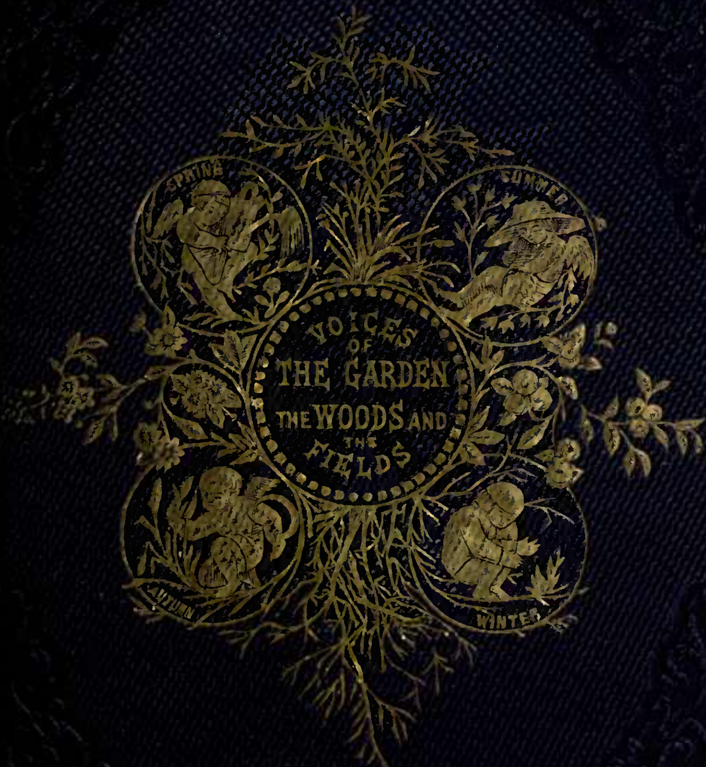
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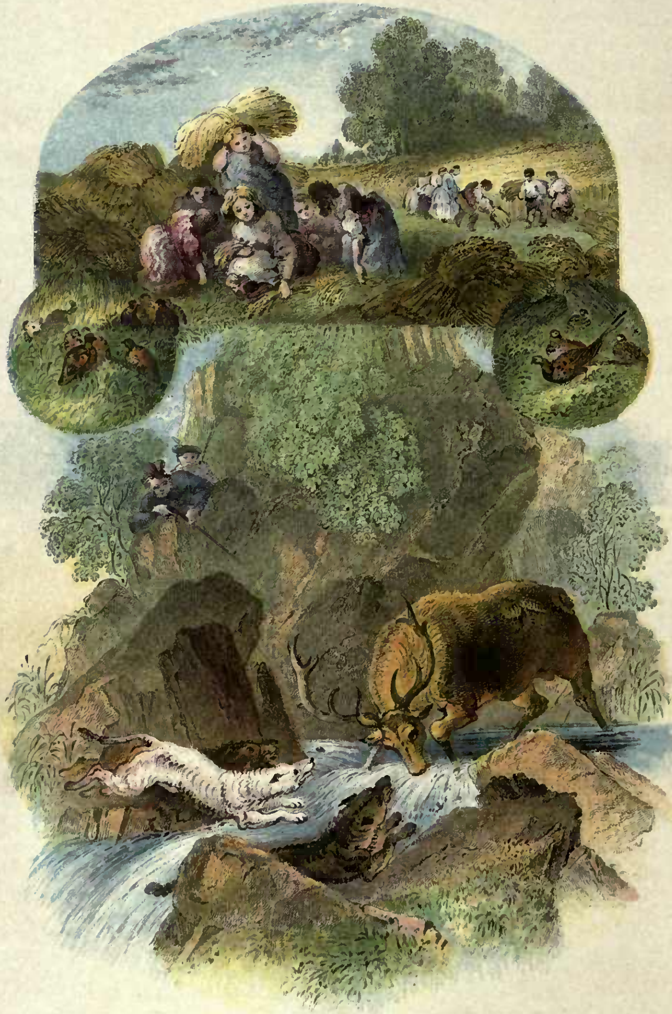
VOICES OF THE GARDEN,

THE WOODS, AND THE FIELDS.



AUTUMN.

VOICES OF THE GARDEN,

THE WOODS, AND THE FIELDS;

OR,

THE TEACHINGS OF NATURE AS SEASONS CHANGE.

BY THE AUTHOR OF
"SUCCESS IN LIFE," "MEMORIALS OF EARLY GENIUS,"
"EVENINGS WITH THE POETS," ETC.

"The world leads round the seasons in a choir,
For ever changing, and for ever new,
Blending the grand, the beautiful, the gay,
The mournful and the tender, in one strain.

PERCIVAL.

LONDON:
T. NELSON AND SONS, PATERNOSTER ROW;
EDINBURGH; AND NEW YORK.

MDCCCLIX.

1859

PREFACE.

To the enlightened eye every scene of beauty is a transparency through which the glory of God is seen; and the ear of faith can hear the voices of Nature singing the praises of God in one harmonious strain. "All his works praise him." "Day unto day uttereth speech, and night unto night sheweth forth knowledge. There is no speech nor language where their voice is not heard." The song of the birds, the whisper of the gentle breeze, the "stormy wind fulfilling his word," and the loud roll of the thunder, unite in softer or louder tones in one harmonious song of praise to him who made them all. There are also silent voices, which those who listen aright can hear. "Mountains and all hills; fruitful trees and all cedars; beasts and all cattle; creeping things and flying fowl:" all that he has made "praise the name of the Lord; for his glory is above the earth and heaven."

The object of this book is to aid the student in Nature's school to listen to these voices, and understand aright the lessons which are to be learned as each season presents its ever-changing succession of pictures to the eye. God has connected moral lessons with each season; but to understand these aright, they must be studied with the light of his written Word. In the following pages an attempt is made to guide the student in thus learning to read the "Teachings of Nature as Seasons change."

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INTRODUCTION.

"To feel, although no tongue can prove,
That every cloud that spreads above
And veileth love, itself is love."

TENNYSON.

THERE are two books which the Creator has furnished for the instruction of man in the knowledge of himself; the one is the Book of Nature, and the other the Book of Revelation. Both, however, may justly claim the title of books of revelation, and it is as such that we are now to consider the Book of Nature, seeking to arrive at an intelligent appreciation of the abundant proofs which it discloses of beneficent design, and of the elevated ideas which it unfolds to us of God as the creator and governor of the universe. "The *Works* of God and the *Word* of God," says the Rev. William Kirby, "may be called the two doors which open into the temple of Truth; and as both proceed from the same Almighty and Omniscient Author, they cannot, if rightly interpreted, contradict each other, but must mutually illustrate and confirm,

though each in different sort and manner, the same truths." It is requisite, however, that the student of the Book of Revelation proceed to the investigation of its truths, in a spirit of teachableness and modest diffidence of his own limited powers of comprehending Divine things, and such is even more needed in studying this Book of Nature which we are seeking to unfold, since it is avowedly an inferior and less perfect revelation, and one which the rash and ill-informed student is still more liable to misinterpret, or read wrong. The Bible alone points out the way to God so clearly, "that the wayfaring man, though a fool, may not err therein;" and therefore it is that, in order to understand the voice of God in creation, we ought to enter the temple of nature with the Bible in our hands.

Many causes have combined in our own day to give a new impetus to the study of the Book of Nature, and perhaps none more so than those great political changes which originated in the first French Revolution. By that overthrow of old prescriptive rights and conventional formulas, it is not to be doubted that the human mind received a fresh impulse, which has led to many important, and not a few beneficial results. Old systems which had grown corrupt in the lapse of centuries, or had stood still and become effete and mischievous, while all around them were advancing with the march of time, were suddenly thrown loose, like a pendulum held by force out of the perpendicular, which we need not wonder should be found to fly far beyond its centre of gravity, and to oscillate with violent vibrations ere it attain to its natural repose. We accordingly find, that in the renovated zeal for the study of nature, the value of the results came to be overestimated, and sceptical philosophy sought to supersede Divine revelation by discoveries of its own. Hence has originated a new system of creation, built up on a false pretence of honouring God, by regarding the

works of his hands as too insignificant for his notice, and ending with not a few in the fancied discovery of some sufficient first cause by which the Divine Creator may be dispensed with altogether.

Foremost among these modern philosophic sceptics must be ranked two of the most distinguished men of science of France, La Place and Lamarck, who have agreed to displace the Divine Creator, by a chance-originating force for which they persuaded themselves no cause need be sought. Yet in the very outset of this godless system of science the necessity of a first cause has to be admitted. "An attentive inspection of the solar system," observes La Place, "evinces the necessity of some central paramount force, in order to maintain the entire system together, and secure the regularity of its motions." Mr. Kirby has well remarked, in commenting on this: "One would expect from these remarks, that he was about to enforce the necessity of acknowledging the necessary existence of an intelligent paramount central Being, whose goings forth were co-extensive with the universe of systems, to create them at first, and then maintain their several motions and revolutions, so as to prevent them from becoming eccentric and interfering with each other, thus—*Upholding all things by the word of his power*. But no—when he asks the question, What is the primitive cause? instead of answering it immediately, he refers the reader for his hypothesis to a concluding note, in which we find that this *primitive* cause, instead of the Deity, is a nebulosity originally so diffuse, that its existence can with difficulty be conceived. To produce a system like ours, one of these wandering masses of nebulous matter distributed through the immensity of the heavens, is converted into a brilliant nucleus, with an atmosphere originally extending beyond the orbits of all its planets, and then gradually contracting itself, but at its successive limits leaving zones of vapours,

which, by their condensation, formed the several planets and their satellites, including the rings of Saturn!"*

The self-originating theory of creation thus assumed by the French philosopher has found a willing phalanx of advocates since, who seem to find it easy to believe any thing except the Bible. In full accordance with this vague and unsatisfying idea of causation, is what has been styled the theory of development, which has been adopted by timid sceptics, unable altogether to dispense with an originating creator, and yet strangely conceiving it most consistent with the honour of the Supreme Being that his works should progress through all their higher changes uncontrolled by his interference, and unaffected by his will. The psalmist devoutly exclaims, "When I consider the heavens, the work of thy hands, the moon and the stars which thou hast ordained, what is man that thou art mindful of him, or the son of man that thou visitest him?" Far different, however, from the spirit of humility that instigated such an exclamation of pious and adoring wonder, is that of the modern philosopher, who admits of a Divinity to set his works in motion, and then requires that he shall stand aside, and leave them to the further developments which may be educible from this supposed originating impulse. "There is a philosophy," it has been justly remarked, "which nobly exercises our reasonable faculties and is highly serviceable to religion: such a study of the works of God as leads us to the knowledge of God, and confirms our faith in him. But there is a philosophy which is vain and deceitful, which sets up the wisdom of man against the wisdom of God, and, while it pleases men's fancies, hinders their faith." It is therefore most needful in the outset of our undertaking that we discriminate between the daring sophistry which substitutes human theories for faith, and makes of reason a Supreme Divinity, and the truthful

* Kirby's History, Habits, and Instincts of Animals, p. xx.

earnest spirit of inquiry, which questions nature, only that its faith may be confirmed, and its devotion enlivened by fresh manifestations of the Divine attributes.

Let it then be understood in the outset that we seek to interpret the Book of Nature, because we discover in its records the same handwriting as that which traced for us the Book of Grace, with its woudrous scheme of Divine love and mercy. It is in the latter only that we can fully trace the Divine benevolence which yet shines through all the works of God. In creation we perceive innumerable evidences of goodness, tenderness, and mercy, but what are the most perfect of these when compared with that revelation, which shows us a holy God looking down in compassion on the unholy, and conceiving the plan by which justice was to be reconciled with the justification of the ungodly. The arguments derived from natural theology are, in fact, of a secondary nature, and altogether subsidiary to the other; nor can we turn them to a good account, or justly interpret their meaning, till the mind has become thoroughly imbued by that living faith which springs from the gospel of God's love and mercy.

Amid the elder nations of the world, the Greeks stand foremost for learning, arts, poetry, and science, and preeminent among the states of Greece was Attica, with its magnificent capital: the seat of all that was most beautiful and rare among the highest productions of human intellect. Taught by her philosophers, Greece had learned from Socrates and Plato, and the wisest of her sons—Epicureans, Pythagoreans, or Stoics,—all that uninspired wisdom could teach; nor has the unaided wisdom of later ages yet superseded the writings of Plato as a guide to that full conception of God, of the human soul, and the eternity to which it aspires, of which unaided reason is capable. In the centre of the area round which the ruined temples of ancient Athens are still traceable, rises the lofty Acropolis, or citadel, with the marble columns of its

magnificent Parthenon; and to the east of this, separated from the Acropolis only by a narrow valley, is the Areopagus, or Hill of Mars, on the eastern and highest extremity of which was the court of the Areopagus in the times of Athenian liberty. In the first century of our era, a learned Asiatic, a native of Tarsus in Cilicia, visited Greece, proclaiming to its philosophers truths unheard by them before. He visited Amphipolis, Apollonia, Berea, and Thessalonica, but in each were found those who scorned the teaching of the Asiatic, and ejected him from their city. In the course of his journey, this learned native of Asia, Paul of Tarsus, was conducted to the chief city of Attica, the seat of Athenian philosophy and arts; but it was with no sense of delight that he witnessed the fruits of its profane wisdom. We are told that while Paul waited for his companions at Athens, his spirit was stirred in him when he saw the city wholly given to idolatry. Therefore disputed he in the synagogue, and in the market daily with them that met him. Then certain philosophers of the Epicureans, and of the Stoics, encountered him. Some said, "What will this babbler say?" Others, "He seemeth to be a setter forth of strange gods!" because he preached to them Jesus and the Resurrection. They conducted him accordingly to the Areopagus, or Hill of Mars, which rose conspicuous amid the splendid edifices of their magnificent city, and standing around him there, they said, "May we know what this new doctrine, whereof thou speakest, is? for thou bringest certain strange things to our ears: and we desire to know what these things mean;" for all the Athenians and strangers who were there spent their time in nothing else but either telling or hearing some new thing. Then Paul stood in the midst of Mars' hill, and said, Ye men of Athens, I perceive that in all things ye are too superstitious. For as I passed by, and beheld your devotions, I found an altar with this inscription, TO THE UNKNOWN GOD.

Whom therefore ye ignorantly worship, him declare I unto you. God, that made the world, and all things therein, seeing that he is Lord of heaven and earth, dwelleth not in temples made with hands; neither is worshipped with men's hands, as though he needed anything, seeing he giveth to all life, and breath, and all things; and hath made of one blood all nations of men to dwell on all the face of the earth, and hath determined the times before appointed, and the bounds of their habitation; that they should seek the Lord, if haply they might feel after him, and find him, though he be not far from every one of us: for in him we live, and move, and have our being. As certain also of your own poets have said: For we are also his offspring. Forasmuch then as we are the offspring of God, we ought not to think that the Godhead is like unto gold, or silver, or stone, graven by art and man's device. And the times of this ignorance God winked at; but now commandeth all men everywhere to repent: because he hath appointed a day, in the which he will judge the world in righteousness by that man whom he hath ordained; whereof he hath given assurance unto all men, in that he hath raised him from the dead.

The sacred historian who has recorded this most interesting narrative, adds: "When they heard of the resurrection of the dead, some mocked; and others said, We will hear thee again of this matter."

Such, then, were all the fruits of Athenian philosophy; with a Plato, a Pythagoras, and a Socrates, to reason of the soul, of immortality, and the sources of created things, God was to the Athenians an unknown being, and the resurrection of the dead a subject of idle mockery. From this the inference is inevitable, that mere human wisdom and natural theology are vain, without the aid of inspired teaching, nor can all the deductions of philosophy from the Book of Nature teach us the simple gospel doctrine

of life and immortality, or tell us the mysterious source of evil, suffering, and death. If, however, we are content to look upon nature as an inferior, and altogether imperfect revelation, which must be studied in the light of higher truths, we shall find in it much to interest and instruct, and shall derive new views of the wisdom and goodness of God from the investigation of his works. It is in this spirit that we now propose to proceed to study them, believing that while the Bible, and the Bible alone, is the revelation of God's will to man, whatever has proceeded from his hands will be found to reflect some evidence of his divine attributes, and to manifest some tokens of his supreme wisdom, benevolence, and power.

The argument of apparent design, on which all natural theology is built, must now be familiar to most readers. It may be simply stated under these two propositions:— First: that design, or the adaptation of means to an end, exists in nature; and, second: that the existence of design implies, of necessity, the existence of a designer. The argument has been thus stated by Dr. Prout: "Animals in cold climates have been provided with a covering of fur. Men in such climates cover themselves with that fur. In both cases, whatever may have been the end or object, no one can deny that the *effect*, at least, is the same: the animal and the man are alike protected from the cold. Now, since the animal did not clothe itself, but must have been clothed by another; it follows, that whoever clothed the animal, must have known what the man knows, and must have reasoned like the man; that is to say, the clother of the animal must have known that the climate in which the animal is placed, is a cold climate; and that a covering of fur, is one of the best means of warding off the cold: he therefore clothed his creature in this very appropriate material.

"The man who clothes himself in fur to keep off the

cold, performs an act directed to a certain end; in short, an act of *design* So, whoever, directly or indirectly, caused the animal to be clothed with fur to keep off the cold, must likewise have performed an act of *design*.

"But, under the circumstances, the clother of the animal must be admitted to have been also the *Creator* of the animal; and by extending the argument; the Creator of man himself—of the universe. Moreover, the reasoning the Creator has displayed in clothing the animal, He has deigned to impart to man, who is thus enabled to recognise his Creator's design."

By the same course of reasoning, we are also enabled, in some degree, to determine what is the character of that Designer and Creator whose works thus lie open for our inspection. Yet here, in an especial manner, we discover the imperfection and inadequacy of our means to such an end, and are led to exclaim, in the language of that ample revelation by which its incompleteness is made up, "Who, by searching, can find out God? who can find out the Almighty to perfection?" We behold, in nature, the varying change of seasons;—the Winter, with its chill frosts, and deadly snow-drifts; its leafless trees, frozen streams, and stormy blasts of driving sleet and snow; yet also with its sleep of inanimate life, as a healthful repose from which all is to awake again at the voice of Spring. With the reviving season come also, doubtless, at times, the chilling frosts which destroy the early blossoms, and defeat the fond hopes of the husbandman and the gardener; yet, as a whole, it is truly the season of hope, and it fails not in an ample realization of its promises. The Summer, also, in many climes, has its disappointing blights, its chill east winds, and unexpected floods in northern regions,—its droughts and pestilences in warmer climates; but it also satisfies, in the main, the character of annual maturity, and fitly ushers in the season of harvest—the Autumn,—with its golden grain, its ripened

fruits, its clustering grapes, and all the beneficent rewards which repay the industry and skill of man. Such is the course of the seasons; some miscarriages and disappointments, some blights, floods, frosts, hurricanes, or deadly failures of crops, in which the lean years eat up the overplus of many plenteous seasons; and, like the ill-favoured kine of Pharoah's dream, when they have eaten them up, it could not be known that they had eaten them, but they are still ill-favoured as at the beginning; yet, on the whole, good predominates, and the promise does not fail. that, while the earth remaineth, seed-time, harvest, cold and heat, summer and winter, and day and night, shall not cease. Apart from the history of our own race, it seems that the course of nature exhibits to us, if not a perfect and unchanging succession of goodness and mercy, yet such a predominance of benevolent provision as satisfies the inquiring mind in the product of all by a beneficent God. Still it is well that at the outset of such an inquiry as we are now undertaking, we should fairly deal with this fact, that storms and blights, hurricanes and tempests, abortive spring-times and unproductive harvests do occur; and more than this, that amid the most lovely scenes of animated nature, pain and suffering, disease and death, are familiar to all. If we are to study the book of nature honestly, and to seek to derive from it true replies to our inquiries concerning the nature of God and the character of his works, we cannot overlook these, because they have long since attracted the attention of earnest inquirers, and have been the source of much perplexity, doubt, and error.

It will clear the way for a just appreciation, not only of the true evidence of the book of nature, but of its right place among the proofs which we possess of the character of God, and the ends of his design, if we fairly meet this difficulty at the outset. In a valuable article published in the British Quarterly Review, entitled: "Chemistry and

Natural Theology;" the following most apposite remarks occur: "The co-existence in this world of life and happiness with suffering and death, leads directly to two questions—Do animal happiness and animal suffering flow from the same source? Is an evil as well as a good being at work in the world?

"In ancient times, and in different countries, a sect existed, known best to us by the title of Manicheans, who held that an evil as well as a benevolent power had a share in the control of all things on this earth. By those holding such a view, all the evil would be referred to the Caco-demon, or malignant agent, and all the good to the Agatho-demon, or good being. The Indian, Persian, Egyptian, and later Alexandrian schools were full of this doctrine. The greatest men of antiquity, however, held no such view, but referred the evil and the good to one source, counting the former either a result of the necessary imperfections of the world-system, or acknowledging it to be a mystery inexplicable. We refer to such opinions, because we think that it is very difficult for us, who consciously or unconsciously, have had all our notions of God modified by what we have learned of him from the Bible, to be certain what conclusion we should have come to, if we had not enjoyed the benefits of a direct revelation. We are certain, however, that science lends no support to a Manichean doctrine. The evil and the good in nature are inextricably intertwined, and cannot be unravelled or disentangled from each other. What is evil in one aspect is good in another, and the two must be taken together, and dealt with as a whole.

"We have no apprehension, accordingly, that the deepest study of any of the physical sciences will lead to the conclusion that this earth exhibits the results of divided counsels, or that such a lesson will ever be taught, as that the happiness of the lower animals is an expression of God's will, and their sufferings the contrivance of some

antagonistic evil demon. All science, we believe, will, with increasing distinctness, join in proclaiming, with Revelation, that 'the earth is the Lord's, and the fulness thereof.' It will then only remain for science to make the fullest proclamation that evil exists, and the frankest confession that she cannot account for it. A dark reality is often more tolerable than a grievous doubt; a hopeless mystery disturbs the spirit less than a difficult, though quite soluble, problem. There are many excellent people afraid, in the face of our natural theologies, to say that physical evil exists, lest they should be thought to impeach God's goodness, and yet troubled by the conviction that evil there is. Let such be emancipated from their bondage, by hearing the student of physical science *ex cathedra* declare that in this world there is 'shade' as well as 'sunshine;' and for those who never could be cheated into the belief that evil was not, or was good, and who stand astonished at its existence, let there be reply also. So long as men look upon the origin and existence of moral or physical evil as a problem which can be solved by logic, they will struggle to the very death to reach the solution; but when they discover that in this world a solution of the difficulty cannot be attained, they will cease to combat with it, and transfer it from the region of the intellect to that of the heart, as a sad and solemn mystery which, with closed lips, will haunt them to their graves.

"Let such hear science acknowledge, that if Plato and Socrates, Aristotle and Galen, could find no plummet able to reach the depth of the mystery of the existence of evil, Newton, Laplace, Herschel, Dalton, or Davy, have not been able to add one inch to the fathom-line, or make it go deeper. They may then, after looking the existent evil in the face till they cease to fear it, perceive that it does not swallow up the good or reduce it to zero, but simply disturbs and perplexes it; but whether they reach this conclusion or not, let the truth be plainly spoken and

acknowledgment frankly made, that after all our natural theologies and prize essays, our eight commissioned Bridgewater Treatises, and ninth volunteered one, physical science must acknowledge that suffering is an enigma which she cannot unriddle. Chemistry, for example, can prove that God is light, but not that 'in him is no darkness at all;' she can show that God *has* love, but not that he *is* love. Before that can be demonstrated to us, to borrow a beautiful idea of Bacon's, we must pass from Vulcan to Minerva; we must turn our backs upon physics and upon all human science, and gaze in another direction, ere we shall be able to affirm that 'the darkness is past and the true light shineth,' or comfort ourselves with the assurance that 'life and immortality are brought to light.' The mystery of pain will haunt our whole lives, and will probably never be felt so keenly as when we are tasting the bitterness of death, and are about for ever to exchange the pangs of this life for the unknown conditions of the life to come. Meanwhile, we are certain that God's benevolence is as infinite as his other attributes, and cannot doubt that some great purpose is served by the suffering of innocent animals. It may yet be given to us to know what it is. And even in this world, all who believe in revelation may contemplate with a joyous eye the good that is in it, and adjourn the explanation of the evil as something traversing, but not neutralizing or annihilating its opposite. Suffering and death may veil, but do not blot out an all-merciful God from our view. The curtain is thick, but light shines through, and words of hope are uttered to all who have ears to hear them. 'Be still, and know that I am God.' 'I form the light, and create darkness.' 'I make peace, and create evil.' 'I have created the waster to destroy.' 'I will swallow up death in victory.'"

The true inference then from the perplexing discrepancies of the Book of Nature, is not that the benevolence

and perfect love of God are controlled by some evil power, but that the Book itself is an imperfect revelation, never designed as a display to man of the perfections of the Creator, but only as a very few leaves out of the great volume of the universe, wherein the Creator has inscribed, and is still writing so many proofs of his vast, all-sustaining, but incomprehensible perfections. To us, the dwellers on this little globe of earth, one of the smallest amid the myriad worlds that move in space, God has given this Book of nature, suited to our wants, and limited to our capacities; but with it he has given us the Book of Revelation, also containing only a small portion of the knowledge of himself which is vouchsafed to some created intelligences, but revealing enough to satisfy all the wise demands of the soul, and beyond this, pointing to the veil, yet to be withdrawn, within which are the things which eye hath not seen nor ear heard, but which are destined for the participants of the promises therein contained.

Let us then proceed to the study of all the wonders and the mysteries which the revolving seasons disclose, not in the spirit of proud scepticism or self-sufficiency, but as modest inquirers, who, already taught by the word of God, that his perfections know no conflict, and his compassion changeth not, seek in his works the opportunities of devout admiration, and not of suspicious questioning or unbelieving fear.

SPRING.

Thou wak'st again, O Earth,
    From winter's sleep!—
Bursting with voice of mirth
    From icy keep;
And laughing at the sun,
Who hath their freedom won,
    Thy water's leap!   HOFFMAN.

CHAPTER I.

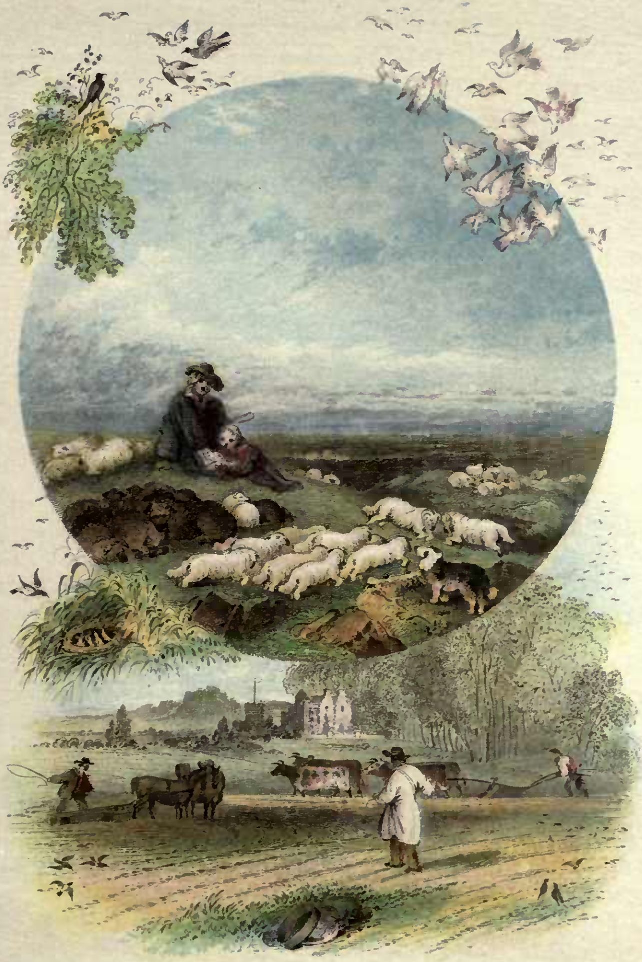
THE FIRST AWAKENING.

ACCORDING to the artificial sub-division of the year, the month of February marks the departure of winter and the opening of the sweet season of spring. In our own native climate of Britain, however, it is at best but a season of hope and promise; and he who will soberly compare his own experience with the rapturous language in which poets indulge, must be strongly tempted to accuse the poets of self-delusion or falsehood. Too many of our native poets have indeed studied the descriptions of the classic muse, rather than aimed at depicting the aspects which they themselves yearly witness, and hence the discrepancies to which we refer. The lavish pictures of mildness and beauty which the poets of the seasons have expended on February, would be exaggerated if soberly spoken of May; and where Thomson, for example, thus apostrophizes spring, we might not unfairly

date much of his details, not in the fickle month of February, but late in the sweet midsummer sunshine of leafy June:—

Come gentle spring, ethereal mildness, come,
And from the bosom of you dropping cloud,
While music wakes around, veiled in a shower
Of shadowing roses, on our plains descend!—
And see where surly winter passes off
Far to the north, and calls his ruffian blasts;
While softer gales succeed . . . .
Along these blushing borders bright with dew,
And in yon mingled wilderness of flowers,
Fair-handed spring unbosoms every grace;
Throws out the snow drop and the crocus first;
The daisy, primrose, violet darkly blue,
And polyanthus of unnumbered dyes;
The yellow wall-flower, stained with iron brown,
And lavish stock, that scents the garden round:
From the soft wing of vernal breezes shed
Anemones: auriculas enriched
With shining meal o'er all their velvet leaves;
And full ranunculas, of glowing red.

There are few springs of our variable northern climate in which we could read these glowing lines of the poet without contrasting them most unfavourably with the chill realities around us. The truth is, our poets have derived such pictures from classic fancy or Italian climes. Beneath the sunny sky of Italy the opening season of the year presents such delights of temperate breezes, bright blue skies, the perfume and beauty of a thousand variety of flowers, and the bursting verdure clothing hill and vale with the robes of spring. It is in such southern climates the most delightful season of all the year, warm without being oppressive, and more lovely in its wild and luxuriant simplicity than all the carefully nurtured exotics of a northern hot-house. But with us spring is the time of hope rather than of realization, and like our own season of youth, delights us far more with promises than performances. It is fitted rather to supply to the poet the em-



SPRING.

blem of human joys which are so much more frequently found to rest in the anticipation of the future than in contentment with what is.

To the invalid the cold east winds of spring are more trying than all the previous rigours of winter, and even the healthy pedestrian who has rejoiced in the invigorating frosts of October, shivers beneath the untimely sleet, or biting winds of February. It borrows, moreover, not unfrequently from the winter; and keen frosts, snowstorms, sudden drifts,—the terror of the shepherd,—and equally sudden thaws and floods, with hoar frosts, sleet, or violent hail, are all characteristic of this fickle, deceitful, and most cheerless month of the year. The peculiar characteristic of the month, however, is damp and fog; and an old Scottish proverb, which still commands implicit faith among the rustic population of many northern districts, thus refers to the second of February:—

> If Candlemas day is fair and clear,
> There'll be twa winters in the year.

Candlemas Day, a memorial of the old services of the Romish Church, falls on the 2nd of February, and should it pass over without rain or snow, the rustic weather-prophet believes the worst of the winter is still to come; while, on the contrary, the more wild and tempestuous the weather proves on that day, it is reckoned the more propitious for the coming summer and autumn. Even the final giving way of the snows and frosts of winter contributes to the cheerless aspect of February. The clear frosty air of winter, however sharply it be felt, seems to add to the cheerfulness of the fireside, and to give a beauty of its own to the desolate face of nature; but the moisture and heavy dews of a spring thaw seem to beget a dreariness that nothing can escape. Clothes, books, papers, the chamber walls, the wardrobes, chests, and

floors seem all affected by the universal damp; and, whether in town or country, the only comfort is in the conviction that the winter is past, and the promised spring is at hand.

Coleridge, no second-hand poet, has written some touching and truthful lines on observing a blossom on the 1st of February:—

> "Sweet flower! that peeping from thy russet stem
> Unfoldest timidly, (for in strange sort
> This dark, frieze-coated, hoarse, teeth-chattering month
> Hath borrowed zephyr's voice, and gazed upon thee
> With blue voluptuous eye,) alas, poor flower!
> These are but flatteries of the faithless year.
> Perchance, escaped its unknown polar cave,
> E'en now the keen north-east is on its way.
> Flower that must perish! shall I liken thee
> To some sweet girl of too, too rapid growth,
> Nipped by consumption 'mid untimely charms?"

Yet while the opening month of spring is thus deformed by many heirlooms of winter, and its flowers seem a premature offspring, born but to perish by untimely frosts, these also are a part of the beneficent system of successive seasons, each in its turn bearing a share in the needful changes of the revolving year. Ungenial as the dawn of spring appears in our rigorous climate, there are not wanting pleasing symptoms that the year has past its descending point, and is advancing, however grudgingly, towards the genial season of returning life and beauty.

A pleasant fancy as to the origin of the snow drop, the pale harbinger of spring, has been woven into some beautiful stanzas, by a dear friend of the author. Picturing the stormy skies and winter's fury bursting over the earth, after the expulsion of our first parents from paradise, when God had cursed the ground for man's sake. He has thus pictured the first impression which winter might produce on the former dwellers in the sinless paradise, and then followed it up with the poetic fancy which intro-

duces the snow drop as the promise and firstling of the spring:—

"And when at last the driving snow,
  A strange, ill-omened sight,
Came whitening all the plains below;—
  To trembling Eve it seemed—affright
With shivering cold and terror bowed;—
As if each fleecy vapour cloud
Were falling as a snowy shroud,
To form a close enwrapping pall
For earth's untimeous funeral.

Then all her faith and gladness fled,
  And nothing left but black despair,
Eve madly wished she had been dead,
  Or never born a pilgrim there;
But, as she wept, an angel bent
His way adown the firmament,
And, on a task of mercy sent,
He raised her up, and bade her cheer
Her drooping heart, and banish fear:

And catching, as he gently spoke,
  A flake of falling snow,
He breathed on it, and bade it take
  A form, and bud and blow;
And, ere the flake had reached the earth,
Eve smiled upon the beauteous birth,
That seemed, amid the general dearth
Of living things, a greater prize
Than all her flowers in Paradise.

'This is an earnest, Eve, to thee,'
  The glorious angel said,
'That sun and summer soon shall be;
  And though the leaves seem dead,
Yet once again the smiling spring,
With wooing winds shall swiftly bring
New life to every sleeping thing;
Until they wake and make the scene
Look fresh again and gaily green.'"

There are few indeed who will not sympathise in the feeling that the first snow drop of spring, seen bursting through the half-melted snow, seems to be worth all the

flowers of summer. How unfit its chaste and delicate blossoms seem to withstand the chill blasts, or to endure the snow-wreaths that gather round it; yet there it hangs its lovely drooping head,

> The first pale blossom of the unripen'd year;
> As Flora's breath, by some transforming power,
> Had changed an icicle into a flower.

Scarcely less fragile, or unsuited for the winter season, are the bright tufts of crocuses that now appear; followed by the hepatica, the mezereon, and the anemones; and accompanied by the shooting forth of many green blades and bursting buds, that give evidence of the icy chains having been snapt, and of nature at length reviving from her winter's sleep. To these, in many a cheerful home, are added the lovely, though artificial children of our northern spring, the sweet scented hyacinths and narcissi, fostered in glasses, and displaying their bulbs and long fibrous roots in the water below. Yet even these, though constrained to an artificial growth, follow also nature's laws, and have their appointed times and seasons, which can only be very partially affected by the constraints of artificial tenderness and fostering zeal.

CHAPTER II.

THE LENGTHENING DAY.

It is not alone in the bursting forth of the snow drop, and the clustering of the variegated groups of crocuses that the first proofs of the advancing year are apparent. The lengthening day already begins to borrow of the night, and the reinvigorated sun wheels in a widening circle through the heavens. The observation of this important phenomenon naturally directs our attention to one

remarkable class of operations of the laws on which the succession of the seasons so greatly depends.

The divisions of time by which our daily and annual rounds of duties and pleasures are regulated, are, to a great extent, not arbitrary, but natural. Each of all the planets which revolve around the central sun of our system has its natural year, on which many of the peculiar characteristics of its periodic changes, and its forms of life also—if such there be—must depend. The planet Mercury, wheeling in its diminutive orbit, measures out the complete circle in a year of two months and twenty-eight days; scarcely equal to the duration of one of our seasons. That of Venus exceeds our half year by little more than a month, while Mars, the first planet beyond our orbit, has a year very nearly double the length of ours. Beyond this, as each succeeding orbit widens, the planetary years increase in length, until we reach Uranus, the remotest of all, save Neptune, yet discovered on the confines of our system; and there the distant orb, tardily moving through its appointed course, has only completed one annual round, when eighty-four of our terrestrial years have passed away, with their successive seasons, and whole generations of men. While glancing at the general laws controlling the planetary system, in their effects on our own terrestrial seasons, it is impossible to avoid the ideas which they suggest of the varied influences of the same laws on the planets that move around us, and on the probability that their changing seasons are also watched by living beings no less interested in returning summer than we ourselves. Yet, if such be the case, how remarkable is the idea this conveys to us of the infinite power of the Creator, and the endless variety of his works. A very slight reflection suffices to show how great must be the changes wrought on each planet by its relative distance from the sun, and hence may we learn how ignorantly they have estimated the works of crea-

tion, who conceive that such changes may be the product of blind chance. The sun shines on the planet Mercury with a force fully seven times greater than on our earth. While its annual seasons, fostered by this sevenfold heat, hurry through all the changes of the year in three of our months. If we could conceive of water, air, and the vegetable and animal life of our planet, unchanged under such a system: think of the quickening pulses of nature, the tropical growth, the speedy ripening, the harvest, winter, and succeeding spring, hastening onward apparently without a pause;—and then—to contrast most fully the varying systems on which our sun looks down—let the reader transport himself in fancy to the remote Uranus, where, while the native of Mercury had reaped his one hundred and sixty-seven harvests, and is busy with the hundred and sixty-eighth, the inhabitant of that distant planet sees but the ripening fruits of his one long protracted year. But we are warned by this of the folly of testing the universe by our own puny experience, or assuming that the great Creator has exhausted his inventive powers on our little sphere. The varied circumstances which we find to pertain to each of the planets of our own system abundantly illustrate the inexhaustible resources of the Supreme Governor of the universe. We are not indeed driven to the idea that all the planets are inhabited, or that every star is the centre of a system like our own. It has been adopted by some good men as a hasty and extreme antagonism to the mean view of the universe which makes it all subservient to our own little planet. "But it would not be a painful, but a pleasant thing, surely, to learn that some of the stars, such as the new planet Flora, were great gardens, like Eden of old before Adam was created; gardens of God, consecrated entirely to vegetable life, where foot of man or beast had never trod, nor wing of bird or insect fanned the breeze; where the trees never cracked before the pioneer's torch,

nor rang with the woodman's axe, but every flower was born to blush unseen." *

This question of the probable occupation of the planets has been the subject of many pleasing, and of some bold and extravagant flights of fancy. The idea of the repetition in other worlds of a state of being, and of creatures similar to those of our own, is thus happily refuted by an intelligent critic:—"Life, as it exists on this globe, is compatible only with certain conditions, which may not be overstepped without causing its annihilation. The whole of these need not be enumerated, as the failure of one is as fatal to existence, as the absence of all. The three to which Sir John Herschel has referred, namely, difference in the quantity of heat and light reaching each globe; variation in the intensity of gravity at its surface; and in the quality of its component materials, may suffice to illustrate this. Light and heat are essential to the development and maintenance of earthly life, but their excess is as destructive to it as their deficiency. What, then, shall we say of the sun, whose heat we know by direct trial to be of such intensity, that after great degradation or reduction, it can still melt the most infusible minerals, and dissipate every metal in vapour; and whose light is so intolerably brilliant, 'that the most vivid flames disappear, and the most tensely ignited solids appear only as black spots on the disc of the sun, when held between it and the eye?' If the temperature of the solid sphere or body of the sun be such as those phenomena imply, it must be the abode, if inhabited at all, of beings such as Sir Thomas Browne refers to, who can 'lie immortal in the arms of fire.' It is within possibility, however, that the body of the sun, is black as midnight and cold as death, so that as the eye sees all things but itself, he illuminates every sphere but his own, and is light to other stars, but darkness to his own gaze. Or the light and

* British Quarterly Review, vol. x., p. 322.

heat of his blazing envelope, may be so tempered by the reflective clouds of his atmosphere, which throw them off into space, that an endless summer, a nightless summer-day, reigns on this globe. Such an unbroken summer, however, though pleasant to dream of, would be no boon to terrestrial creatures, to whom night is as essential as day, and darkness and rest as light and action. The probabilities are all in our favour of the temperature of the sun's solid sphere being very high, nor will any reasonable hypothesis justify the belief that the economy of his system, in relation to the distribution of light and heat, can resemble ours.

"We can assert this still more distinctly of the planets. We should be blinded with the glare, and burnt up, if transported to Mercury, where the sun acts as if seven times hotter than on this earth; and we should shiver in the dark, and be frozen to death, if removed to Uranus, where the sun is three hundred times colder than he is felt to be by us. To pass from Uranus to Mercury, would be to undergo in the latter exposure to a temperature some two thousand times higher than we had experienced in the former, whilst on this earth the range of existence lies within some two hundred degrees of the Fahrenheit thermometer." *

Sir John Herschel says of our satellite, "The climate of the moon must be very extraordinary: the alternation being that of unmitigated and burning sunshine, fiercer than an equatorial noon, continued for a whole fortnight, and the keenest severity of frost, far exceeding that of our polar winters, for an equal time." It would seem then, that though all else were equal, the variations in amount of light and heat, would alone necessitate the manifestation of a non-terrestrial life, upon the sun, and the spheres which accompany the earth in its revolutions around it. All else, however, is not equal. The inten-

* British Quarterly Review, vol. x., p. 349.

sity of gravity at the surfaces of the different heavenly bodies differs enormously. At the sun it is nearly twenty-eight times greater than at the earth. "The efficacy of muscular power to overcome weight, is therefore proportionably nearly twenty-eight times less on the sun than on the earth. An ordinary man, for example, would not only be unable to sustain his own weight on the sun, but would literally be crushed to atoms under the load. Again, the intensity of gravity, or its efficacy in counteracting muscular power, and repressing animal activity on Jupiter, is nearly two and a half times that on the earth, on Mars it is not more than one half, on the moon one sixth, and on the smaller planets probably not more than one twentieth; giving a scale of which the extremes are in the proportion of sixty to one." *

But are we thence to conclude that amid the myriads of worlds and suns that glitter nightly in the vault of heaven, our planet alone is occupied with sentient life, while all the universe besides is an unpeopled waste? Such an idea cannot be entertained. Imagination vainly strives to comprehend the mysteries of these surrounding worlds, and "by searching to find out God." Let it suffice for us to learn thereby how infinite are the wondrous diversities of creation, while it may be that, returning from expatiating on these innumerable suns that stud night's arch, to reconsider the state of our own little planet, we may indulge the possible thought that, amid countless worlds, teeming with life and joy, and basking each in the rays of their appointed sun, ours alone, of all the attendant planets, may perchance possess the sad pre-eminence of sin,—the sole world whose inhabitants have proved rebels to God.

We need not, however, wander into the immensities of space, and search with aching eyes for the footsteps of God among the stars. There are abundant traces of the

* Herschell's Outlines of Astronomy, p. 311.

Divine Governor of the universe in our own little planet. It is not so insignificant as to be beneath his care. With the telescope new suns and systems have been revealed to us on the remote confines of space, but with the microscope it is found that a whole world of sentient life is concentred within a drop of water, or on a single leaf. We turn, therefore, with no sense of constraint, to follow the seasons in their appointed course, feeling assured that many volumes may be written without exhausting the lessons which they teach. As the dead season of winter passes away, and, with the lengthening day, the sunny smile of the warm sun increases in power, all nature appears to feel and to rejoice in the genial heat. There seems a harmonious adaptation of it to the requirements of nature. In our own climate we witness no violent or sudden vicissitudes such as are known within the Arctic circle or the torrid zone. It is, in every sense of the word, a temperate climate which we enjoy, and while we recognise the same beneficent God ruling over all his works, we may be permitted to admire the mutual adaptation of all living things to it, and of it, to them. It is true, indeed, that it is far more the adaptation of animal and vegetable life to the climate, than of it to them. The flowers, the rice, the palms of the tropics, will not grow under our changing skies; their birds and beasts can scarce be kept a few years, with all the aid of artificial substitutes. Even the vines of France grow sterile, and the myrtles of Greece and Italy wither before our frosts. But while such natural laws rapidly eradicate all but a few transplanted exotics, we too have our fields of wheat and corn, and our verdant meadows, such as would wither under tropical skies. Some of these have been artificially introduced, and in truth, if we explore our orchards and gardens, and investigate the history of their contents, we shall find scarce an aboriginal native among them all. Into these we shall inquire more at large as

we proceed; but meanwhile it is well that we should guard our subject against overstrained and false deductions. Of the many exotic plants, fruits, and flowers which have from time to time been introduced into our gardens and orchards, only a small portion have been found to possess capabilities suited to the varying conditions of our climate. The remainder have died out and disappeared, and thus, while we recognise the beneficent design which cares for the perpetuity of animal and vegetable life in our variable climate, we must not overlook the fact that the balance of means, to ends which seems so nearly perfect, is the result of an adjustment by which imperfections have been not so much corrected as eradicated. Each climate and locality retains what was intended or is fitted to be appropriated by it, and the remainder perishes like an untimely birth.

There are two diverse, yet singularly consistent phenomena in the disposition of vegetable life throughout our planet, which mutually illustrate each other. On the one hand we perceive the vivifying effects of the invigorating warmth of the advancing seasons in the development of a constant succession of plants and trees, and on the other hand we see their geographical distribution, coexistent with the successive gradations of climate, and variations of local influences between the Polar regions and the equator. The two classes of phenomena may be said to run nearly parallel and mutually to illustrate each other. On ascending a mountain in the torrid zone, for example, it is found that the higher we rise, the more vegetation loses its characteristic features, and assumes those of other zones, until towards the summits of the loftier mountains the stunted saxifragas and mosses, which form the sole vegetation of the Polar regions, make their appearance and there also skirt the line of perpetual snow. To the interesting subject of the geographical distribution of plants, however, we shall have occasion to return, mean-

while we seek rather to observe those annual changes which mark the return of spring by the revival of vegetable life and floral beauty. These attractive signs of renewed life, and of the genial return of warmth and sunshine, have been subjects of pleasant welcoming at all periods, and in every country inhabited by man. The Greek and Roman poets abound in such allusions. The Egyptian hieroglyphics and paintings, as well as the symbolism of their strange mythology, point, in many ways, to the same welcoming of vegetable life, and its pleasing concomitants, while among the many strange relics discovered at Coptos, Thebes, and others of the most remarkable Egyptian sites, a number of Chinese vases have been found, pertaining, as is presumed, to a remote period in the history of that singular people, on one of which this brief but beautiful legend has been deciphered, in the old Chinese characters:—

"The flower opens, and behold! another year."

From the peculiar geographical position of our own native island, the changes of climate are much more gentle and gradual than in countries lying many degrees nearer the equator. In looking at a physical chart of the globe the isothermal lines passing through the midland counties of England, are seen to descend obliquely through the continent of Europe, impinging on the Black Sea, and passing through the southern portion of the sea of Asaph, some ten degrees farther south, while to the westward it is found to embrace New York, in nearly 40° north latitude, or fully fifteen degrees nearer the equator than the same line of temperature in England. These isothermal lines, or zones of equal annual mean temperature, however, only mark one of the sources of peculiarity of climate. Along with the isothermal map, that of the rain system must be studied as of next importance, and from it we see that, in addition to the peculiar mildness

which pertains to the British islands, chiefly from their insular position, they also owe to nearly the same causes their exposure to an amount, and tolerably equal distribution of rain throughout the year scarcely known elsewhere. To this we owe our fertile meadows, and the rich green herbage which so strikes the eye of a stranger on our closely cropped lawns, or rugged, yet verdant Highland hills; and from this also, with all its mixture of good and evil, Ireland derives the characteristic beauitful from whence it has received the title of the Emerald Isle.

In the British islands, the vicinity of so large an area of sea, always in winter at a higher, and in summer at a tower temperature, preserves us from the sudden vicissitudes which mark, in many countries, the transition from winter to spring. In Polar regions, where, during nine months in the year, the soil is frozen in one solid mass, hard as the rocks that it rests upon, the brief bright summer requires to proceed with a vigour altogether unknown to us, in order to accomplish the requisite processes of maturity and reproduction, before nature is once more locked in the iron embrace of its dreary winter-time. Something analogous to this, though greatly differing in degree, is experienced in the northern temperate regions both of Europe and America. In Canada, where the sledge is almost universally substituted for the wheeled carriage so soon as the winter sets in, a very few weeks elapse, after the melting of the snow has warned the traveller to resume the more common vehicle, when the intense warmth of summer has set in, and the bud, blossom, and fruit, are seen following each other in rapid succession. This sudden intensity of heat occurs, indeed, even within the arctic circle. There the snow begins to fall as early as August, warning the dreary settlers in such inhospitable regions that the season of natural life and activity is at an end. The frost settles down, and one icy chain binds all nature in its fetters as in a sleep of death from which it can never

again awake. Captain Parry remarks, in describing the winter passed by him at Melville Island, "The sound of voices which, during the cold weather, could be heard at a much greater distance than usual, served now and then to break the silence which reigned around us; a silence far different from that peaceable composure which characterizes the landscape of a cultivated country: it was the death-like stillness of the most dreary desolation, and the total absence of animated existence."

The sleep, however, is not that of death. At length the cheering sun reappears above the horizon, seen, indeed, by the aid of refraction, some days before his actual rise, in a direct line of vision in such latitudes. In the month of May, the famished inmates of the rude snow huts and pits venture forth in quest of fish on the margin of the sea. Daily the sun acquires greater elevation and increasing power. The snow melts away, and masses of the rapidly dissolving ice, detached from the cliffs, and undermined beneath, precipitate themselves on the shores with the crash of thunder. The ocean is now unbound, and its icy dome broken up with tremendous rupture. The enormous fields of ice, thus set afloat, are, by the violence of wind and currents, again dissevered and dispersed. Sometimes, impelled in opposite directions, they approach, and strike with a mutual shock, like the crash of worlds,—sufficient, if opposed, to reduce to atoms in a moment the proudest monuments of human power. It is impossible to picture a situation more awful than that of the crew of a whaler, who see their frail bark thus fatally inclosed, expecting immediate and inevitable destruction.

Before the end of June, the shoals of ice in the Arctic Seas are commonly divided, scattered, and dissipated. But the atmosphere is then almost continually damp, and loaded with vapour. At this season of the year, a dense fog generally covers the surface of the sea, of a milder temperature indeed than the frost-smoke, yet produced

by the inversion of the same cause; the lower stratum of air, as it successively touches the colder body of water, becoming chilled, and thence disposed to deposite its moisture. In the course of the month of July, the superficial water is at last brought to an equilibrium of temperature with the air, and the sun now shines out with a bright and dazzling radiance. For a certain time before the close of the summer, such excessive heat is accumulated in the bays and sheltered spots, that tar and pitch are sometimes melted, and run down the ships' sides.

Notwithstanding the shortness of the summer in the high latitudes, the air on land becomes often oppressively sultry. This excessive heat, being conjoined with moisture, engenders clouds of mosquitoes, from the stings of which the Laplanders are forced to seek refuge in their huts, where they envelope themselves in dense smoke.

It may naturally excite our wonder that, in a climate where even the brief heat of summer seems only to bring a change of privations and sufferings, human beings should be found content to reside amid its prolonged frosts and brief but burning summer suns. Providence, however, extends with divine care over all the works of nature, nor would the Laplander exchange his snows for the verdure of the temperate zones or the luxuriance of the tropics. Our English poet Cowper, in his beautiful description of Liberty, thus apostrophizes his country:—

> Thee I account still happy, and the chief
> Among the nations, seeing thou art free;
> My native nook of earth! Thy clime is rude,
> Replete with vapours, and disposes much
> All hearts to sadness, and none more than mine:
> Thine unadulterate manners are less soft
> And plausible than social life requires,
> And thou hast need of discipline and art
> To give thee what politer France receives
> From Nature's bounty—that humane address
> And sweetness, without which no pleasure is
> In converse; either starved by cold reserve,
> Or flush'd with fierce dispute, a senseless brawl.

Yet being free I love thee: for the sake
Of that one feature can be well content
To seek no sublunary rest beside.
But, once enslaved, farewell! I could endure
Chains nowhere patiently; and chains at home,
Where I am free by birthright, not at all.
Then what were left of roughness in the grain
Of British natures, wanting its excuse
That it belongs to freemen, would disgust
And shock me. I should then with double pain
Feel all the rigour of thy fickle clime;
And, if I must bewail the blessing lost,
For which our Hampdens and our Sidneys bled,
I would at least bewail it under skies
Milder, among a people less austere.

But our variable climate, replete with vapours though it be, has other attractions besides the political privileges enjoyed beneath its changing skies. We do not, indeed, experience the rapid changes above alluded to, where the sharp yet exhilarating frost is suddenly succeeded by summer's warmth and life, but, in lieu of this, we have a periodic succession of seasons almost as numerous and regular as the months of the year, and each with a character and beauty of its own, which is looked for and enjoyed by us with a zest little less exhilarating, and more continuous, than that of those who pass almost without transition from winter to summer.

As the day begins to lengthen, the earliest flowers peep forth, and throughout each successive month, almost till the frosts of Christmas, with its roses and crimson holly-berries, a continuous series of fresh buds and flowers give ever renewing interest and beauty to the British floral garden. The moderate heat, and the inconstancy of our summer weather, is counterbalanced by the absence of any remarkable severity in the cold of winter, so that in the average temperature of the latter period of our year, the climate is only such as to cast the trees and shrubs into a state of inaction, in which vegetation nearly ceases, and they may be described as asleep. As the days begin

to lengthen, and the sun rises higher in the heavens, the increasing warmth of his rays dispels the traces of the night's frost before the morning is far advanced. It is now, however, that the frost is most severely felt. With the warmth of the reinvigorated sun all nature seems to awaken from its winter's sleep. The buds begin to swell; the earth cracks and makes way for the tender shoots of the snow-drop and the crocus, and soon the fruit-trees begin to put forth their buds and shoot into blossom. It is rare, however, that an early spring passes over without the hopes of the orchard being nipped by these untimely frosts; and the gardener and amateur agriculturist must often look, with a sense of unavailing mortification, on barren trees which had delighted their eyes in the first months of spring by the profusion of their blossom. In this, however, the thoughtful reader will learn to read one of the most striking though mysterious lessons which is recorded for us in the book of nature. The presumptuous mind, seeking to fathom the ways of Providence, is sometimes prone to rebel against the present evil, and to question the perfection of the Divine proceedings, when gauging them by its own standards of completeness and incompleteness, of good and evil; but the devout study of the operations of nature in these meaner things may teach us how incapable we are of comprehending the purposes of Providence, or, by searching, of finding out the Almighty to perfection.

> Behold! we know not anything;
> I can but trust that good shall fall
> At last—far off—at last, to all,
> And every winter change to spring.

No recent writer has dealt more tersely, yet profoundly, with this conflict of thought and experience than Tennyson, in his beautiful poem "In Memoriam." After giving full expression to the natural thought, that, under the rule of an infinitely wise and beneficent Creator, the whole

works of the universe should develope an ultimate perfection and universal happiness, and "that, somehow, good must be the final goal of ill." He thus gives expression to his wiser thoughts :—

The wish that of the living whole
  No life may fall beyond the grave;
  Derives it not from what we have
The likest God within the soul?

Are God and Nature, then, at strife,
  That Nature lends such evil dreams?
  So careful of the type she seems,
So careless of the single life;

That I, considering everywhere
  Her secret meaning in her deeds,
  And finding that of fifty seeds
She often brings but one to bear;

I falter where I firmly trod,
  And falling with my weight of cares
  Upon the great world's altar-stairs
That slope through darkness up to God;

I stretch lame hands of faith, and grope,
  And gather dust and chaff, and call
  To what I feel is Lord of all,
And faintly trust the larger hope.

CHAPTER III.

THE SOIL.

Among the various traces of a former order of things, which gave place to that dispensation of which we now partake, we seem to be naturally led back to a stage in the history of our planet, in which its sterile and barren rocks were unclothed with soil, and totally incapable of

sustaining animal or vegetable life. Rocks and water were, to all appearance, the sole features visible on our planet, throughout one long epoch of unknown duration. A gradual change, however, was taking place on this bare and sterile globe. The action of the atmosphere, of rains, floods, rivers, and frosts, all united to effect a continuous disintegration of the rocks. The washing of rains, and of running waters tended constantly to carry such disintegrated particles into the lower valleys, estuaries, and great ocean beds; and thus throughout periods, as we have every reason to believe, of vast duration, the whole soil was being spread over the lower valleys, or swept into the lakes and seas, partially filling up, and levelling the low grounds with this alluvial deposit, and encroaching upon the dominion of the waters; but, by the same means, preserving the greater part of the dry land as a rocky and sterile waste.

Other actions, however, were tending to modify the effects of this class of operations. Moisture, rain, and the influence of currents and floods had been superinduced upon a still earlier class of active powers by which our planet was gradually made ready for the living occupants that now inherit it, and among these the chief agents were heat and fire. The former class of operations carried the crumbling soil into the ocean beds, to be still further pulverized, and equally spread over vast surfaces of the lowest superficial levels, and then came the agency of fire, sometimes by means of the sudden outbursts of the volcano or the violent upheaval of the earthquake, disturbing the whole subaqueous arrangements, covering vast surfaces with ashes, scoriæ and lava, and heaving up large submerged areas at once above the level of the waters, and occasionally far above the neighbouring land. In other cases, the result was probably far more gradual, corresponding to the slow but continuous operations still familiar to us, by which some portions of the continent of

Europe, as well as others within the volcanic districts of America, are even now being raised at the rate of about a foot in a century. To such a class of operations, there appears every reason for ascribing not only the upheaval of great table lands, but even the elevation of many mountain ranges covered with the debris accumulated in the depths of ancient oceans.

It has been justly observed by Malté Brun, that "The structure of the globe presents, in all its parts, the features of a grand ruin." Such an idea is still more strongly impressed on our minds by recent investigations of geologists. The older strata of the earth's crust are dislocated, jostled together, and piled in vast confusion, with the embodied traces of many successive scenes of violence and overthrow. Yet here also we perceive that amid all this apparent ruin the Creator was working out far higher ends. The destruction resembled that of the ploughshare, which tears through the green sod, overturns the wild growth of many seasons, and doubtless seems to the little insect crowd whose abodes it invades, to be working irretrievable ruin, while all the while it is only making the needful preparations for fertility and future abundance.

But something further was needed before the naked rocky skeleton could be clothed with the soil and fine mould on which all successive vegetable and animal life should depened. The mere pulverization of the rock would, for the most part, have produced little else than barren sand, scarcely more fitted as a preparative for vegetable life than the hard rock from which it had been detached. Chemical agents, however, were at work, animal, as well as vegetable life also, developed originally in inferior forms, continued probably through long ages to add the needful decomposing vegetable matter, the exuviæ, and the calcareous spoils of marine animals, by which, in the depths of the ocean, a soil was gradually formed fitted to sustain vegetable life, when it should by

other operations of nature, be separated from the superincumbent waters.

We see, in all the phenomena here referred to, a singular combination of decay and destruction, with progress, reproduction, and the systematic preparation for newer orders of being. But we may also discover in it evidence of the important fact that this planet is neither a thing which has existed from eternity, nor which is destined to endure for ever. "The everlasting hills," as they are called in the fine imagery of scripture, are subject to changes scarcely less constant than those which the seasons bring round to the most fragile plant, or to the grass of the field. The expanding frost, acting on the water which has penetrated into the fissures of rocks, rends them asunder with irresistible force, and year after year precipitates successive masses of the loftiest cliffs into the valleys below. There is no point at which such operations cease so long as any fragment of the rock remains at its elevated height. Not in huge fragments only, but in avalanches and land slips also, vast masses are hurled down bearing ruin in their paths; damming up mountain streams, flooding valleys, and totally changing the whole character of extensive districts of country. So too by the slower, but not less certain agency of rains, streams, floods, and the decomposing action of the atmosphere, the land is being slowly borne seaward, and estuaries and vast marine valleys are being filled up. Time alone is required for the vast results which we now trace to such simple effects, nor is their action either very slow or inconsiderable. We see then that it is not man alone, or the animal and vegetable creation, which are characterised by inevitable elements of decay. The earth itself waxes old. It has already passed through changes abundantly analogous to those of childhood and youth, and it appears to be inevitably destined to a like maturity and decay. These are indeed the processes from whence we

begin to perceive that the Creator evolves higher states of being. The barren rock, apparently crumbling into ruins, is only preparing the soil with which it is to be clothed with a higher beauty: the waters stripping the soil from off the land and sweeping it into the estuary or the ocean, are only providing the alluvium with which to enrich other hills and valleys with greater luxuriance, and a more productive soil; the dying millions in the antediluvian waters were adding another needful element to the same superficial element of vegetable life; the tropical vegetation of the like periods swept away by floods, accumulated in rotten masses in creeks and estuaries, or spread out over vast submerged plains,—the picture apparently of utter ruin and desolation,—are found to have been providing stores of fuel for the higher orders yet to be created; and thus what seem to us confusion and death, are only the needful preparations to higher developments of life. All things suffer change, but order springs out of confusion, and life out of death; may we not also perceive in this, evidence anticipatory of that new heavens and new earth, which we are taught to believe are to succeed to this one when it shall be dissolved, and its elements shall melt with fervent heat.

Our present object, however, is to glance at the various processes by which, out of the bare rocky planet-crust, a rich soil has been educed, clothing the hills and valleys, like flesh upon the dry bones, and preparing them for the breath of life filling all their diversified surfaces. The mere crumbling down of the rock, as we have observed would in very few cases supply the elements of vegetable life. Soil, consisting only of such comminuted particles is of no further use than to supply to plants and trees the means of retaining a hold on the surface. But the root which thus takes hold of the soil, also furnishes the vessels by means of which nourishment is to be drawn into the plant; and not a few of the requisite sources of

nourishment need only light and moisture to educe them from this soil. The more common ingredients of rocks, which actually constitute the greater bulk of every soil, are silex, alumina, lime, magnesia, and iron. To these are added some few earthy matters, salts, and decayed animal and vegetable remains; the latter restoring constantly to the soil what the living plant abstracts from it.

It is justly considered a proof of providential design that, from such sources a productive soil should be educed, and fertility secured by a considerable nicety of adjustment, making it at once retentive and porous, capable of receiving, retaining, and yielding up moisture, as well as the solutions which it prepares from its original crude elements. Still nature admits, and provides for, a great latitude in the character and capabilities of the soil, which again exercise a marked influence on vegetation. The marks of design are still more apparent in the creation of a multitude of plants, adapted to such a diversity of local circumstances, that the bleak mountain summit, the low bog, the saltmarsh, and even the nearly bare rock, have each their natural and healthful occupants, which demand such localities for their peculiar constitution. Soil and climate are indeed the two most prominent causes affecting the development of vegetable and animal life, and will come under our consideration repeatedly, in considering the various phenomena which they exhibit. Meanwhile it is interesting to note this adaptability of nature from which a universal and consistent harmony results. Abstractly considered, the requisites for the life and healthful growth of a plant are a rich soil, light, heat, and moisture. Yet under circumstances where each of these are found deficient, plants are clothing the waste in healthy enjoyment of all that the necessities of their peculiar nature demand. "More than enough," says Dr. Prout, "has been stated to show the wonderful arrangements that have been made, to ensure

the clothing of every part of the earth's surface with vegetable organization. There is not a soil, however barren, nor a rock, however flinty, that has not its appropriate plant; which plant has no less wonderfully found its way to the spot adapted for it, nay, will perish if removed elsewhere. Saline plants, for instance, will grow only where saline matters are abundant; plants of the marsh, and of the bog, flourish only in marshy and boggy ground; those of the parched desert and of the cloudy mountain, each in its fitting locality. Thus the soil and its occupant seem to have been made for each other; and hence one source of that astonishing variety exhibited in nature."

Other equally remarkable variations are noticeable in the plants of different regions and countries which will come to be noted in their order, all serving to show how inexhaustible are the phases under which vegetable life can be healthily developed, and how countless are the manifestations of Almighty wisdom and power even in this one little section of creation. "Lo! these are parts of His ways; but how little a portion is heard of him. The thunder of his power who can understand?"

CHAPTER IV.

VEGETABLE LIFE.

THE phenomena which excite our wonder and engage our attention in connexion with inert matter are sufficiently surprising, and impress the mind with a solemn awe from the stupendous scale on which many of them are displayed, and the vast periods of time over which the full process of their development extends. But far more wonderful and mysterious to us is the principle of life

even when exhibited in its very lowest forms of organized existence. The poet has been accused of a sentimental exaggeration, when, in his indignant protest against cruelty to the lower creation, he exclaims :—

> "The very beetle that we tread upon;
> In mortal suffering feels a pang as great
> As when a giant dies."

There are, however, both truth and wisdom in these lines. To the well regulated and thoughtful mind, the death even of a fly or of some noxious earwig by our own hand, when its intrusion has seemed to justify the stern act, must seem a sad necessity. Its life is a gift from God; the same God in whom we live. That wondrous mechanism of limbs, muscles, and feelers, wings, and eyes, feathery down, or glancing plates of mail, which reveal ever new wonders and beauties under the microscope, and put to shame all the mechanical ingenuity of our steam engines and machinery—that wondrous mechanism is God's handywork, and the life which we thoughtlessly extinguish is His gift, and its enjoyment one of the ends for which he created it.

The butterfly which flits from flower to flower, or the

> Bees that soar for bloom,
> High as the highest peak of Furness-fells,
> And murmur by the hour in foxglove bells;—

the house-fly finding ample verge enough in the moty sunbeam that enters through some unguarded chink, or even the unsightly grub, or ear-wig, that seem to the careless eye as blots on the garden, and intruders among pleasant fruits and flowers: are all capable of an enjoyment as amply suited to the capacities of their nature, as we are of pleasure, and also of pain. How harsh an act is it needlessly, and without provocation, to tread out that mysterious and wonderful gift of life, which more than all else in nature speaks to us of God, and which not all the wisdom or ingenuity of man could restore! He

who can imagine that the God, who created these creatures of his hand a free to enjoy his gifts as we are, will be heedless of their destruction, must forget the divine declaration, that not even a sparrow falls to the ground without his knowledge.

This mysterious principle of life is the greatest and most incomprehensible wonder that excites our curious interest, and proves the limits of our human knowledge. The body animated with life, while wrapt in the restorative repose of sleep, and the same body in the destroying grasp of death, seem at the first glance so nearly similar, that they are not always to be discriminated. Yet how mighty is the difference between

"Death and his brother Sleep!"

The contrast puts all the boasted wisdom of man to shame. It surpasses his knowledge to tell what that wondrous animating principle is which, dwelling in this tabernacle of flesh, sustains in vigour and beauty, what becomes on its departure a loathsome thing we hasten to bury out of our sight. The same mysterious principle of life, though in a lower degree, animates the vegetable world. In the sacred narrative of the creation, after the gathering together of the waters into one place had made the dry land appear, and "God saw that it was good, he said, Let the earth bring forth grass, the herb yielding seed, and the fruit-tree yielding fruit, whose seed was in itself after his kind." It seems indeed that the young earth was made for a time the garden of God, as an intermediate preparative for other and higher modes of being. These things of beauty, the living plant, and the flower, while clothing the bare earth with their novel and wondrous groups of animated beings, were to be employed in evoking new elements from the crude, unorganized crust of the earth, and gradually adapting it for the next order of beings which were to succeed to the inheritance.

One department of the researches of the modern geologist, styled "Palæontology," includes the investigation of the animal and vegetable life of geological eras long prior to the creation of man, and from this we derive some knowledge of the peculiar character of the primitive flora in that springtime of creation to which we refer, when God was first "clothing the grass of the field." At that stage of our world's history the formless and the void had been only partially displaced, and vegetable life assumed considerably different forms from those with which we are now most familiar. The oldest of all traces of primeval vegetable remains are supposed to be the fucoids of the silurian beds, but the evidence of their distinct vegetable nature is not yet clear or entirely conclusive. The plants of some other early geological epochs are also still very imperfectly known; but it is otherwise with the important flora of the carboniferous epoch. The peculiar forms and character of the great majority of the fossil plants of the coal measures, furnish indications of the very peculiar conditions of the earth's surface at the early period to which they are assignable; while the existence of such enormous beds of coal, extending over vast areas, strikingly prove the abundant vegetation which existed during that epoch. Ages must have elapsed during which the singular forms of vegetable life preserved in the coal measures continued to be propagated, and to flourish in far more than tropical luxuriance, gradually preparing the earth for higher orders of being. Now, the living plants most nearly resembling them are found only in tropical countries, and largely contribute to impress on the vegetation of these latitudes its peculiar physiognomy. In the Polynesian Islands much that is suggestive of a resemblance to these early periods of the development of vegetable life is still apparent; but the comparison requires many deductions, and leads to the study of the latter only as analogous types, in some degree akin to the

giant forms of vegetable life which abounded in that early period of creation.

The points of resemblance, as well as of contrast, between animal and vegetable life, present subjects of interesting study. The mode of subsistence of the vegetable, and almost the first property necessary for its life, is the power of absorbing the needful constituents of its being from the surrounding elements. It is, accordingly, provided with a root by which it takes hold of the soil, and by the direct agency of which it is fed. A distinguished botanist has indeed aptly defined a plant as "a living body deprived of sensation or power of moving from place to place, and fed by means of external roots." With these it imbibes from the soil in which it is placed the needful fluid or sap by which it is sustained, and by this apparently simple apparatus the whole important and complicated chemical processes are carried on, and the crude soil converted into the needful constituents of vegetable matter. The elementary bodies which form the essential constituents of sap are carbon, oxygen, hydrogen, and nitrogen. These combine and form various secondary bodies, in which state they are most frequently absorbed by the plants. For this purpose, the root possesses certain structural characteristics, adapting it to its peculiar functions. The ramifications are irregular, differing in this respect from the symmetrical arrangement of the branches. The smaller divisions, or *fibrils*, as they are called, consist of little bundles of ducts, or spiral vessels, surrounded by woody fibres, lying in a mass of cellular tissue. Towards the point of these fibrils the tissue is loose, and the outer covering wanting, so that they rapidly absorb the fluid with which they are surrounded and brought in contact. Roots are divisible into various classes, according to their form, mode of development, duration, &c; but the purpose of all is the same. They receive and readapt the food necessary for

the sustenance of the plant: digesting it, and converting it, with the needful aid of light and heat, into the healthy sap or vegetable blood which circulates through the veins of the living plant. Adapted as they are also for attaching the plant to the soil, they exhibit all the diversity which pertains to lowly shrubs or plants, and tall umbrageous trees, the one having only its tender rooty fibres, terminating with the *spongioles* or special organs for reception of nutritious moisture, while the other are provided with ingeniously-adapted and widely-branching roots, capable of taking firm hold of the ground, and resisting the tremendous force with which the tempest assails the trees of the forest. This latter character peculiarly pertains to plants as living bodies destitute of the power of moving from place to place. In other respects, however, the roots supply the same functions in the plant as the absorbent vessels do in the animal. The organs of absorption are, indeed, very differently situated in the two, the animal deriving its nutriment from the stomach—an internal reservoir, into which it has previously introduced the needful and most select elements of nourishment, while the vegetable organs of absorption act exclusively on the external soil. They do not, however, receive all with which they are brought in contact, but select and reject, with a discrimination not less wisely adapted to their requirements than the instincts of the lower animals. The power of absorption by the roots of plants has been explained to be due to the capillarity of the cellular tissues of which they are composed. Such an explanation, however, in so far as it seems to indicate a mere mechanical process, cannot satisfy the mind; for the process goes on healthily during the life of the plant, but no sooner does vitality cease, from whatever cause, than these fine capillary tubes, which had acted with such seeming mechanical regularity before, altogether fail, and the dead plant retains its wonderful con-

trivances of tissues, fibrils, spongelets, cells, pores, and sap vessels, to as little purpose as the human body, is possessed of all its wondrous anatomy, when the spirit has returned to God who gave it.

The living principle thus present in the plant, and quickened into activity with the returning warmth of spring, exhibits a vital activity closely allied in some respects to that of animals, though in others altogether different; and especially in that retention of the vital principle under certain conditions, as when grain is laid by, or seeds are buried in the ground so deep as to be beyond the reach of light and air. In this way, also, the winter frosts serve to keep the seeds of the previous autumn in a dormant state until the returning warmth of spring sets them free, and, under the genial influence of the warm moisture and porous soil, they germinate, and shoot up into stem and leaf. Here, however, we see one distinct line of argument presenting itself to our mind, the force of which it is impossible to gainsay or resist. The gardener or husbandman, by soils and manures, by draining or forcing, or, again, by grafting, transplanting, and training, can work many marvellous changes on plants, flowers, and fruit; but the original mystery of vegetable life—the vital principle without which all else is vain—remains as mysterious and inexplicable as ever. Reason as philosophy may, by means of all the lights of science, and all the wonderful and mysterious laws which modern discoveries have revealed, we are still brought back to the simple argument of a child, which intuitively discerns the necessity of a first cause, and finds ample satisfaction in the assurance that God made all these things—that he said, "Let it be, and it was so."

CHAPTER V.

THE YOUNG PLANT.

WE are naturally led, in the consideration of all that relates to the season of spring, to investigate the infancy of vegetation, which, quickening into life under the genial influences of the opening year, then presents itself to our observation under this aspect. The provision contained in the seed for the life and germination of the new-born plant, is a most interesting and remarkable evidence of wise design. In the grain of wheat, for example, as in that of barley or oats, the embryo plant is a minute point, filling but a very small space within the husk or covering; while the remainder is occupied with a starch or glutinous matter, as directly designed for the nourishment of the young plant when first quickened into life, as is the milk in the mother's breast for the sustenance of the new-born child. This arrangement is still more obvious in the cocoa-nut, where the true embryo plant is a little point at one end, weighing only a few grains, while the edible core which is to supply it with its earliest nutriment, weighs many ounces. In the bean or pea this nutritive matter is contained in the fleshy lobes which appear as a part of the young plant, and are called the cotyledons, that is, the seed-leaves; and above these speedily appear the first pair of proper leaves, entirely differing from them in form.

The natural process by which vegetable life passes from its dormant state into active development is at once explained and illustrated in the process of malting, by which the brewer and distiller prepare the barley for conversion into ale or whisky. The vital but dormant seed there contains the provision for the future nourishment of the plant in the state of starch, and, being in-

soluble in water, it is inapplicable for that purpose. The maltster, however, by exposing it to moisture, warmth, and air, speedily begets the first process of germination. The grain begins to sprout, and when examined is seen to have shot out the root, and the first rudimentary indications of the stem. Along with this, however, a radical change has taken place on the whole seed; the starch has become sugar, and, were the process of germination allowed to proceed, would be entirely absorbed for the nourishment of the young plant. The object of the maltster, however, has been attained by the superinduction of this saccharine matter, and he immediately arrests the process—which would defeat his purpose by further progress—by putting it in the kiln, and exposing it to a regulated heat sufficient to destroy the vital principle, without injuring the saccharine matter thus developed. In this state it is malt—no longer capable of being turned to use by the husbandman, but ready to be stored away for the further processes of the brewer or distiller.

When we consider these remarkable natural processes by which the dormant seed is quickened into life, we may see how apt and beautiful are the Scripture illustrations derived from them. The language is accepted as the most suitable and expressive which nature offers. The Divine Word is the seed—the human heart is the soil—and the Great Teacher is the husbandman. The Parable of the Sower derives its chief force from the effects of varying soils and other natural influences on the newly-sown seed: which, however good in itself, only springs up and bears fruit when it falls into good ground; so, too, the influence of the Holy Spirit is represented as descending like the dew on the tender herb, as the rain upon the mown grass, and as showers that water the thirsty ground. Then the gradual quickening of divine grace implanted in the human heart is likened to the slow development of the cereal plant—"first the

blade, then the ear, then the full corn in the ear;" so, also, the influences from above, on which the quickening of grace in the human heart must depend, are beautifully likened to the early and the latter rain—the former the refreshing showers of spring, and the latter the autumn rains which fell in the goodly land of Palestine when the corn was ripening, filling the ears with the nourishment it supplied, and giving joy to the husbandman by the assurance of an abundant harvest.

These natural and obvious illustrations present themselves in their full force to all minds. There are others, however, no less striking, though less obvious, and especially that remarkable one, "Except a corn of wheat die it abideth alone; but if it die it bringeth forth much fruit." Here the reference is to that remarkable provision in the seed for the nourishment of the plant, which has been already described, and which nearly corresponds to the albumen of an egg. The wheat is available to us as "the staff of life," one of the most essential elements of human sustenance, entirely because of that provision of nutritious matter which forms the bulk of the seed, and is destined to nourish the embryo plant in its first stage of being. So soon as vegetation commences, and the embryo plant has begun to absorb this little store, the seed is rendered as unfit for our nourishment as an egg in which the chicken is already formed. Both are spoiled, and *dead*, according to common language, and have lost the available qualities by which our life is sustained, by the very changes consequent on quickening and vitality.

By considering these simple processes of vegetable life, we discover a new force and fitness in some of the most remarkable expressions which Scripture contains. Hence the beauty of the idea of the resurrection as typified in the quickening seed, and of our risen Saviour as the first-fruits of them that slept. It was with

this transformation in his mind—incident to the vital processes of vegetable life occurring on each returning spring—that the Apostle exclaimed, when writing to Corinth—"That which thou sowest is not quickened, except it die; and that which thou sowest, thou sowest not that which shall be, but bare grain; but God giveth it a body as it hath pleased Him, and to every seed its own body. So also is the resurrection of the dead. It is sown in corruption; it is raised in incorruption; it is sown in dishonour; it is raised in glory; it is sown in weakness; it is raised in power; it is sown a natural body; it is raised a spiritual body." This is not the mere language of fanciful illustration, but an argument derived from the ordinary processes of the lower forms of life, to demonstrate that new spring-time and future harvest, anticipated by the believer as a change, to which the death of the natural body is as essential as the change that takes place on the quickening seed,—which, except it die, cannot spring up and partake in the annual resurrection of the opening year.

CHAPTER VI.

THE ROOT.

The consideration of the root of the plant, on which all else depends, properly belongs to the season of spring, when in the newly-developed plant it is first formed, both to take hold of the soil, and to provide the nourishment by means of which the life and increase of the plant is to be maintained. No sooner does the seed soften and swell, and the quickening process begin, than the root begins to protrude downward. The moisture which has contributed to awaken its dormant vitality to life, has

also softened the soil in which it lies, and so loosened its particles that the soft and tender fibrils of the root are able to insinuate themselves through it, and spread abroad in search of the needful nourishment. The cells by which nourishment is chiefly received have already been described as placed chiefly at the extremities of the roots, and as the elongation of them takes place entirely there, the root is thus enabled gently, yet ceaselessly, to advance and accommodate itself to the nature of the soil in which it grows.

The capabilities of such a gradual process often receive remarkable illustration in trees which have sprung up on a rocky soil, or amid ruins. Frequently an aged ruined castle may be seen, in some crevice of the massy walls of which a seed chance-sown by the autumn winds has taken root, and by and bye the spreading roots of the young tree, seeking everywhere for moisture, insinuate themselves in every crack and crevice of the wall, and, as they gradually increase in strength and size, dislocate the whole mass, which had seemed capable of resisting the wasting tooth of time for centuries. Rocks are, in like manner, rent by the same gentle yet unceasing operations; nor is it infrequent to see, on some of the Highland hills which are clothed with the dwarf-oak, the gnarled and twisted roots embracing and sustaining immense masses of stone, which they have gradually dislodged and uplifted in their progressive growth.

The same process takes place in the acorn, destined to quicken and germinate into a plant which shall grow for centuries; and in the corn, which will ripen into maturity in the succeeding months of summer and early autumn. As the stem shoots upwards, and puts forth the blade or leaves from which the moisture is respired, the roots continue to seek it in new soil, and to renew the delicate absorbing cells, by which they are enabled to take up the needful supplies of nourishment

for its increasing bulk. By this reception of nourishment, chiefly at the extremities of the roots, another needful adaptation of the arrangements of parts to their mutual relation is observable; and while we take shelter under the umbrageous covering of some widely-spreading tree, we may reflect on this wise provision, by which the rain dropping off from leaf to leaf, is at length chiefly deposited on that part of the soil where the delicate absorbing fibrils of the roots are waiting with open cells to drink it in. The wider, indeed, the branches spread, the further the roots extend. While trees which are hemmed in in some overcrowded plantation, excluded alike from sun and air, grow stunted in form, and languid in growth: the timber—the produce—is poor in quality, and they are so little prepared to stand alone, that, should the surrounding trees, by which they are thus imprisoned and made sickly, be at length cut down, they are liable to be levelled with the ground by the first succeeding gale, so slight is the hold which their roots have taken of the soil.

This constant relation between the spreading of the branches and the extension of the roots, is obviously designed, in part, where the disciples are likened to the branches in Him, the true vine; and so also the like affinities supply many other striking illustrations of Scripture. "There shall come forth a rod out of the stem of Jesse, and a branch shall grow out of his roots," is the spiritual language of prophecy relative to the coming of the Messiah; but the figure is speedily changed, and the Branch is also styled the *Root of Jesse.* So, also, in relation to the essential elements of the Christian life: "If the root be holy, so are the branches;" "being rooted and grounded in love;" and "rooted and built up in Him." These, and many more Scripture illustrations, derive a new force when we consider the nature and operations of that germinating process which the husbandman watches

on each returning spring, and tends with a solicitude derived from the conviction, that if the first tender fibrils of the root are nipped or poisoned, all further hope of harvest is at an end.

The roots of plants develope themselves in many ways; sometimes being provided with reservoirs of nourishment, as in the potato, the turnip, the orchis, and other tuberculous roots. In these a still greater amount of nourishment is preserved than in the starch of the cereal seed, and destined to furnish supplies at a later period; yet the essential correspondence of the two classes become apparent from the artificial uses to which both are applied. The potato is made to yield flower and starch as well as the wheat, and the carrot and beet-root have long been made available as a substitute for the sugar-cane. They are also capable of being applied to the purposes of the distiller, and alcohol may be procured from the potato no less readily than from barley. Plants provided with roots of this class belong, for the most part, naturally to dry and sandy soils, where the tubercle furnishes a reservoir for the nourishment of the plant during the long droughts, in which the common fibrous root would seek in vain for moisture, if not thus stored up for the time of need. In this sense we may understand the expressive simile of the prophet when the rejected Messiah is spoken of as a root out of a dry grouud—a root still full of nourishment and health for its own branches, though deriving no life from the arid soil around.

It is obvious, thus, how deserving of our study are the simplest phenomena which the seasons disclose in their progress. The commonest weed, and the plainest and most homely of the grasses, without flower or leaf to attract the eye, are yet full of interest and beauty to those who study them. All nature seems to lie open with inviting looks to court investigation, and to add to our stores of knowledge; but at no season is this so impressed on us

as in the first sunny days of spring, when the earliest flowers are waking from their winter sleep, and the ice-bound earth seems thawing into life. There is something very enticing as well as remarkable in the breaking through the soil of the early spring plants. Under the keen frost we see the earth a solid clod, nearly as hard as the underlying rock. By and bye the sun's genial warmth softens this; we observe it cracking and rising up here and there, as if from some active force below. Then, at length, the green sheath of the crocus appears, which expands into the delicate yellow or purple flower, so soft and tender looking, that it seems as little capable of contending with the biting frosts of the spring as a new-born infant. Not so, however: tender though it looks, it is a hardy child of spring, and thrives without complaining or suffering from its lot. The primrose, another harbinger of the season, is the more common favourite, if not the true native spring plant celebrated by the older poets. Beaumont and Fletcher speak of it as—

"Primrose, first child of Ver,
Merry spring-time's harbinger,
With her bells dim."

Possibly the lovely snow-drop was unknown among us—like many other of what we now consider old-fashioned flowers—till a later date. Certain it is, however, that all now recognise it as the true firstling of the year, the aconite and the Christmas rose being regarded rather as the offspring of winter. It is at its invitation that we hasten out, amid the half-melted snow, and flatter ourselves that the winter at length is past, and open-handed spring has come.

Up, let us to the fields away,
And breathe the fresh and balmy air;
The bird is building in the tree,
The flower has opened to the bee,
And health, and love, and peace are there.

CHAPTER VII.

THE SEED-TIME.

The seed-time and harvest—the summer and winter—are the designations applied from earliest times to the seasons of the year. The spring-time is, in truth, that of the sower preparing his soil, casting his seed, and then watching for the fertilizing showers which are to quicken it into life; and hence the frequent comparison of the probationary season of youth to the year's seed-time; for that once neglected, no diligence or labour, however great, can recover the lost time: but, on the contrary, if the soil have been ploughed and manured, and made ready, but yet have received no seed, the foul crop of weeds will only be the more abundant and rank. This is, indeed, an extreme case; but yet many homely proverbs suffice to show the universal sense of the value attached to the diligent employment of the preparatory season; such as that which pronounces a peck of March dust to be worth its weight in gold. "Every month," says William Howitt, "like a good servant, brings its own character with it;" and this is the character to be desired for March, when the husbandman wants a dry soil to crumble under his plough, instead of cutting through in a solid mass, like a cake of moist clay. He wishes to get his seeds into the well-broken ground, and to have them sown regularly and equally through the field, so that every inch of soil may be found occupied in autumn with the abundant harvest. This done, and then welcome April with her fertilizing showers, swelling the seeds, and quickening them into vigorous and healthy vegetation. "In comes January," says Howitt, when remarking on the character of the months, "and let the weather be what it might before, immediately sets in severe cold and

frost: in February, wet—wet—wet, which, the moment March enters, ceases; and lo! instead—even on the very first of the month, there is a dry, chill air, with breaks of sunshine stealing here and there over the landscape. The clouds above fly about with a brisker motion, and the paths under our feet, which yesterday were intolerably miry, become at once solid and dry. The change is surprising. Twelve hours of March air will dry the surface of the earth almost to dustiness, even though no sunshine should be seen; and 'a peck of March dust is worth a king's ransom,' says the old proverb, which we may suppose means that the drying property of March is invaluable, removing the superabundant humidity, and enabling the husbandman to get in his seeds, the hope of summer produce. So speedily does the mire of winter vanish in this month, that country people, who connect their adages —which, though significant, are not literally true—with something which makes them partially so, say, 'the rooks have picked up all the dirt,' because the rooks are now busily employed in building their nests, and use mire to line them, as do magpies too at this period, who place their thorny halls on the tops of the yet leafless trees—objects conspicuous, but secure.

"March is a rude, and sometimes boisterous month, possessing many of the characteristics of winter, yet awakening sensations perhaps more delicious than the two following spring months, for it gives us the first announcement and taste of spring. What can equal the delight of our hearts at the very first glimpse of spring —the first springing of buds and green herbs? It is like a new life infused into our bosoms. A spirit of tenderness—a burst of freshness and luxury of feeling possesses us; and let fifty springs have broken upon us, *this* joy, unlike many joys of time, is not an atom impaired."*

The novelty of spring seems, indeed, one of the very

* Book of the Seasons, p. 61.

few things which never palls on us. The first snowdrop of the year is welcomed with perhaps even more zest by the old than the young; and all acknowledge an eloquence and beauty in the anticipatory lines of the simple familiar hymn—

> "There everlasting Spring abides,
> And never-withering flowers;
> Death, like a narrow sea, divides
> This happy land from ours."

A country ramble on a clear bracing morning in March is one of the most delightful treats that can be experienced by "one long in city pent." The air is just sharp enough to afford a pleasant stimulus to the exercise of a smart and prolonged ramble. Though the trees and hedgerows are still bare, the buds are beginning to show signs of life, and already the blackbird and thrush are in song, and the lark is mounting up in the clear-blue sky, and carolling with the continuous flow of its thrilling music. Through the open hedges, or the wide palings that fill in the gaps, the rambler catches a glimpse of the ploughman with his team, or hears beyond the plantain, in some more sequestered and solitary cross-road, the ringing of the horses' gear, as they turn at the end of the furrow, and the lively, hillarous notes of the driver direct them to the new soil.

Few facts connected with the vitality and growth of seeds are more remarkable than those which have been observed on the turning up of new ground. The endurance of the vital principle of seeds appears to be something altogether different from anything we know in animal life. Numerous occurrences appear to indicate that the seeds of many plants and flowers, after lying dormant in the earth for ages, have quickened into life on exposure to sun and air.

This subject is illustrated by many interesting observations in "Jesse's Gleanings in Natural History." To a

shrewd observer of nature, thousands of such striking examples present themselves which escape the cursory glance of unintelligent and heedless ramblers. "Few things," he remarks, "appear to me more curious than the fact that the seeds of various plants and flowers, which have lain dormant in the ground through a succession of ages, have either, by being exposed to the air, been enabled to vegetate, or have been brought into action by the application of some compost or manure agreeable to their nature." The proofs of this are of the most varied sort. Mr. Jesse instances that of the *Hypecoum procumbens*, which, after having entirely disappeared from the Upsal garden for a period of forty years, was accidentally restored merely by turning up the ground it had formerly occupied. A species of *Lobelia*, which had been missing for twenty years in the Amsterdam garden, was unexpectedly recovered in the same manner. A still more remarkable example of the same kind is recorded to have occurred in London, soon after the great fire. A species of mustard, the *Sisymbrium Iris*, grew up on all hands, covering the ruins and recently-exposed soil with its yellow blossom; and, as if to prove some curious affinity between the conflagration of cities and this common class of plants, after the more recent burning of Moscow, the *Sisymbrium Panonicum*, another species of the same plant, made its appearance among the ruins, and is still to be met with in the neighbourhood of that city.

It would appear that seeds covered by a slight overlying soil germinate on their exposure to warmth, moisture, and air. A little lower down probably the moisture alone reaches them, and destroys them by causing them to rot; but when sufficiently buried to be beyond the reach of these influences, there seems no lapse of time known to us during which their vitality may not remain dormant, and ready to be excited into healthful action when exposed to the needful influences.

In referring to this long vitality of seeds, Mr. Jesse remarks:—"This was shown in trenching for a plantation a part of Bushy Park, which had probably been undisturbed by the spade or plough since, and perhaps long before, the reign of Charles I. The ground was turned up in the winter, and in the following summer it was covered with a profusion of the tree mignionette, pansies, and the wild raspberry, plants which are nowhere found in a wild state in the neighbourhood; and in a plantation recently made in Richmond Park, a great quantity of the foxglove came up after some deep trenching. I observed, a few years ago, the same occurrence in a plantation in Devonshire, the surface of which was covered with the dark blue columbine,* a flower produced in our gardens by cultivation, and I believe not known in this country in its wild state. A field, also, which had previously little or no Dutch clover upon it, was covered with it after it had been much trampled upon, and fed down by horses; and it is stated from good authority, that if a pine forest in America were to be cut down, and the ground cultivated, and afterwards allowed to return to a state of nature, it would produce plants quite different from those by which it had been previously occupied. So completely, indeed, is the ground impregnated with seeds, that if earth is brought to the surface, from the lowest depth at which it is found, some vegetable matter will spring from it. I have always considered this fact as one of the many surprising instances of the power and bounty of Almighty God, who has thus literally filled the earth with his goodness, by storing up a deposit of useful seeds in its depths, where they must have lain through a long succession of ages, only requiring the energies of man to bring them into action. In boring for water lately, at a spot near Kingston-on-Thames, some earth

* Mr. Jesse observes:—I have since learnt that the columbine is found wild in the western counties.

was brought up from a depth of three hundred and sixty feet; this earth was carefully covered over with a hand-glass, to prevent the possibility of any other seeds being deposited upon it, yet in a short time plants vegetated from it."*

It is marvellous to conceive of the operations that must have been going on through long periods of time to produce such results. Yet among the gigantic changes on land and ocean, the upheaval of continents, the filling-up of estuaries, and all the vast geological events that have combined to produce the present aspect of things, the overruling Providence whose unseen hand directs the whole, has not been unmindful of the little weed and wild-flower, deep buried in the changing earth. What force do such reflections confer on the language of inspiration: "If God so clothe the grass of the field, shall he not much rather clothe you, O ye of little faith!"

The seeds of plants and trees are not alone designed for the preservation of the species; they supply also the food of multitudes of the lower animals, and are not without their value, in this respect, to man also. But while by this use of them the larger number of seeds are annually destroyed, the same means tends also to promote their diffusion. Squirrels, rooks, field-mice, and many other animals, bury seeds in the ground, probably for the purpose of afterwards feeding on them, but thus unconsciously lead to the growth of plants and trees in localities, which, but for such instinctive operations, their seeds would never reach. But even after they have been taken up for food, many seeds still preserve their vitality, and are thus still more widely disseminated, under the most favourable circumstances for growth, especially by birds. "Some seeds are provided with a sort of down, by which they are carried, with the help of the wind, to

* Gleanings in Natural History, p. 138.

great distances; and others fix themselves on the ground by means of a glutinous substance attached to them.

"It is a curious fact, in proof of what has been advanced, that more recent deposits of earth, such as peat, leaf-mould, &c., produce little or no vegetable substances, while, as has been shown, soil, from whatever depth it is brought, is impregnated with seeds, which grow freely on being exposed to the influence of light and air.

"The coral reefs in the South Seas are first of all covered with marine substances, then with the excrements of birds, in which are undigested seeds, that spring up and flourish in the deposits which have been formed on the reefs. So various are the ways in which a beneficent Providence has enabled the earth to produce food for the benefit of his creatures, making an insignificant insect, and perhaps a small migrating bird, instruments by which he shows his power and goodness.

"Many plants show a great fondness for particular spots, and it is not easy to eradicate them from it. In looking over an old 'History of Middlesex,' I found mention made of a very small mountain-pink, which had been discovered on a mound of earth which was pointed out in Hampton-Court Park. I went to the place at the time of the year when those plants are in flower, and readily discovered this pretty pink. Not one plant, however, could I find away from the mound, though I have repeatedly looked for them, nor are there any of the same variety growing wild in the neighbourhood."*

The clothing of the bare coral reefs of the southern ocean by such remarkable yet simple means with verdure and beauty, is a striking evidence of the inexhaustible resources of nature. The tides also lend their aid, floating branches of trees, laden with their seed, to a distance of many hundreds of miles, and thus making even the gales and tornados, which seem fitted only to rend and to destroy,

* Gleanings in Natural History, p. 142.

contribute to fertilize and to extend vegetable life, by sowing on the ocean the seeds which are destined to take root and spring up on distant isles. The great fertility which is promoted by the constant resort of sea-birds to such rocks and islands is also shown by the immense accumulation of guano, or birds'-dung, found in such localities, and which has been proved to be so valuable a manure, that it has been imported in ship-loads to our British ports, and readily sold at high prices, for the purpose of enriching our less-luxuriant soils.

Another curious example of the continuance of plants in favourite spots, notwithstanding the use of all ordinary means for their eradication, has been noted in the illustrations of a favourite old Scottish ballad, "The Broom o' the Cowdenknowes." The Cowdenknowes, or, as the name is sometimes spelled in old writings, the Colding Knowes, are two little hills on the east side of the vale of Lauderdale, Berwickshire. One version of the ballad is known to have been printed in the reign of Charles II., but a still earlier one is given in the Minstrelsy of the Scottish Border. Mr. Chambers remarks, in his notes on Scottish Songs: "Of the two hills which bear the general designation of the Cowdenknowes, the highest is called the Black Hill, on account of its being still covered with dark natural heath, while the lowest is termed the White Hill, because it is now subjected to the plough, and accordingly whitened with grain during a considerable portion of the year. It is believed by the people of the neighbourhood, that the broom, which has long been gone, would again spring up in all its wonted luxuriance, were it not for the sheep and the plough; and they instance, as a proof of their assertion, that, some years ago, on the White Hill being left fallow for a short time, the native shrub actually did begin to reappear.

"In the ballad of the Cowdenknowes, particular allusion is made to the *length* of the broom; and that it really was

very long, is proved by the tradition of the people, who, it may be remarked, preserve as vivid, if not also as tender a recollection of it as the love-lorn heroine of the song. In its primitive state, say these faithful chroniclers, it grew so tall and so bushy, that a man might ride through it on horseback and not be seen from any spot in the neighbourhood. The editor himself has seen a stalk of the venerated plant, which happens to be preserved by a gentleman of that district, and he can attest, that it reached from the floor to the ceiling of a lofty room. This fact forms the best possible commentary on the song; for how many fragrant and secluded nooks, calculated for scenes of courtship, must there have been throughout such a territory, and by what greater cause of endearment could such a heroine have been inspired! These forests of broom were, moreover, in themselves extremely beautiful and interesting objects. Before the recent improvements in Scottish agriculture, there were to be seen everywhere throughout the country, whole districts which waved, a sea of glorious yellow, beneath the autumn wind; while, for miles around, the ground was covered with the blossoms which they shed." *

The seed being planted in the fit soil, the vegetation succeeds, to which we have already referred, accompanied by other and no less striking manifestations of creative omniscience and design. No sooner has the dormant seed been awakened to life than the embryo root, and stalk or plume, make their appearance—the one invariably shooting downward, and the other upward, so that each may fulfil its destined part in the economy of nature. Here, as in so many other instances, the wise adaptation of means to an end becomes apparent. It has been attempted, indeed, to explain this from natural causes, and no doubt, like all the other laws of nature, it presents a consistent harmony with the whole scheme of

* Scottish Songs, vol. i., p. 249.

vegetable life. The root being designed to lay hold on the soil, and seek its nourishment underneath the surface, is obviously in its natural state when excluded from the light; while the latter is essential to the healthy development of the plant, to the colour of its leaves, and all the varied odour, pungency, and beauty of its flowers. Still in this, as in so many other cases, those who have attempted to discover a sufficient law in the necessities of each, by which the former must seek darkness, and the latter light, have been mistaking effect for causes.

There are plants, indeed, which will grow though suspended in the air, and in many extensive hot-houses a variety of such singular aerial plants may be seen, with their roots exposed to the same light as the branches. We are familiar, also, with the growth of bulbous roots, and especially hyacinths, in glasses, where the exposure of the roots to the sun in no degree affects the full development of the flower, and the delightful fragrance of its odours. The same also is seen in the germination of grain for the brewer or distiller, in the shooting of potatoes, onions, and other roots when housed, as well as in other instances familiar more or less to all. In every seed the embryo plant already exists, with its radicle and plume, or root and plant, yet no displacement of the seed prevents this arrangement taking place. Whether the seed be flung without any arrangement as to position, as by the sower when scattering the wheat or oats, or carefully dibbled in, naturally standing according to its purpose of growth, or deliberately reversed for the purpose of examination or experiment, the result is still the same. "These tendencies," says a scientific writer, when treating on the subject of Vegetable Physiology in the "Encyclopædia Britannica," "have been ascribed to the action of light on the plume, and of earth on the radicle; but the radicle equally descends although no earth be present, and the plume rises although light be

excluded." The same writer specifies a variety of conjectures which have been hazarded—such as the weight of the sap, or even simple gravitation, causing the descent of the radicle; but all such theories have been found to fail when subjected to the test of experience; and meanwhile we must be content to recognise in this, as in the vital principle from which it originates, a primary law implanted in it by the Creator, for the purpose of accomplishing the ends necessary for its being, precisely as the instinct of the new-born infant teaches it to suck, and that of the bird leads it to seek a mate and build its nest in spring, or the bee to construct its waxen cells, and to store up the honey for its winter supplies.

The rise of the sap, which takes place in trees so soon as the genial warmth of spring has awakened the dormant vegetable life from its winter's sleep—the perspiration by the leaves, and the development of the flowers and fruit in succession—all manifest the same wonderful harmony and completeness of design as are exemplified in the germination of the little seed, and the progress of its various members, each suited to the special functions on which the life and health of the plant depend. Some of these will come under our notice in considering the various phenomena which pertain to later seasons of the year; yet enough has been already seen to demonstrate the fulness of the Book of Nature in evidence of their divine origin, and of the wisdom and harmony which is visible in the minutest and apparently most trivial of these creations of God: whose providence is over all his works, and his hand as visible in the noxious weed or the unsightly worm, as in the wondrous mystery of the human frame, or the ordering of the mighty universe, which the most powerful telescopes have been vainly employed to fathom.

CHAPTER VIII.

INSECT LIFE AND INSTINCT.

THE reanimation of vegetable life with the first dawn of the genial spring time, has furnished some pleasant and profitable grounds of reflection on the power and wisdom, and goodness of God. And when we consider, that not alone in the cultivated field, or on the natural pasturage that surrounds the habitations of men, but in the remotest wilds: in the vast plains of Central Asia or America, under tropical suns, or even amid the polar snows, "where human foot has never trod," each returning season brings its verdant and flowery clothing, we see a striking evidence of the inexhaustible power and beneficence of the Creator. We shall now, however, quit for a time these proofs derived from inanimate nature, and following up the works of God in higher forms of development, we shall find new sources of wonder and delight in the varied manifestations of curious instincts, intelligence, and reason, which mark each successive link in the chain of living beings rising step by step up to the rational and immortal creatures to whom has been given dominion over all the rest. Man alone, superior to the instincts by which all else are guided, pursues his plans, and regulates his affections, independent of the changing seasons. The instinctive propensities and habits of all other living beings pursue a round of changes coincident with those that follow the sun's annual path through the heavens. So soon as the autumn harvest has been gathered into the barn, and the chill frosts of October have begun to displace the ripening warmth of harvest time, the hum of insect life rapidly diminishes, the notes of the wood songsters are hushed, the summer visitors, larks, swallows, martins, and the like, muster for flight to

warm climates; and soon little else is heard than the plashing rain, or the noise of the wind-gusts sweeping through the leafless trees. It seems the death of nature, but it is only its sleep. No sooner is the wintry blast over, and the returning spring has begun to reclothe the trees, and revive the verdure of the meadows, than the animation of insect life reappears, the songs of the birds become more musical than ever, and the time of love and of mating manifests the continuance of those remarkable instincts by which the continual succession of every order of living being is sustained amid the apparent universal prevalence of waste, decay, and death.

The entire subject of the instincts of the lower animals forms one of the most attractive and inexhaustible themes for the investigation of the student of nature. Man, as a rational, moral, and accountable being, is provided with faculties for benefiting by experience, and receiving instruction from a thousand different sources. Born a helpless, naked infant, with a probationary season of youth, protracted through fully twenty years, and accompanied with the gradual development of successive faculties and desires, he profits by the example of others, and shares in the experience of generations long returned to the dust. Every age witnesses some change, and most of them some important progress. And even when, as with thousands in every age, the good old rule suffices them of doing as their fathers did, it is a matter of imitation and habit, derived from experience, and altogether different from the unerring instincts of the lower animals. With these no parental monitor warns or advises; no moralist restrains, and no teacher discloses to them the secrets of novel arts. The caterpillar, which knows nought of its butterfly parents, and dreams not of ever soaring on the air, weaves its silken coil, constructs its nest by binding the edges of the leaf around it, and passes into its strange second stage, the wintry state of

the chrysalis, having provided all needful appliances for its awaking, without sharing in the experience of a single elder caterpillar, or the grave monitions of one full grown butterfly. Another season comes round, and the same warmth which vivifies the seed and makes it sprout, awakens the dormant energies of the chrysalis, and casting off its slough, it flies abroad to seek its mate, and fulfil the great law of Nature in the continuation of its species. Without previous knowledge or experience, its innate instincts guide it at once to its own proper food, and also teach it to deposit its eggs where the future caterpillar shall find its appropriate, though totally different nutriment.

The manifest differences between such instincts and reason based on experience, have long attracted notice, and excited much interesting discussion. The broadly marked contrast between the proceedings of a man of education and experience, and those of the newly fledged insect just spreading its tiny wings to sun and air, are indeed so obvious, that though they must attract notice, they would seem to have little room for variety of opinion. In this subject, however, as in most others, there are coincident points where it is hardly possible to discriminate between the two. There is a point where vegetable life ends and animal life begins, the precise limit of which it is perhaps impossible to define. It is scarcely possible, for example, to draw the line between the motions of the lowest species of animals, such as the mollusca, and those discoverable in some plants. Their mode of propagation, as well as of growth, are also nearly identical. There is in both organized forms a circulation of fluids through vessels, and the secretion of solids by means of these. But even the motions observable in many plants, or the peculiar phenomena occasionally manifested by them when forced to grow under disadvantageous circumstances, often seem to approximate to the instincts manifested in

the lower forms of animal life. Of this class are the motion of the sun-flower, as well as of other flowers which follow the course of that luminary through the heavens as if to enjoy his beams; the closing of flowers at sunset, and the varied changes they display according as the weather may chance to be from day to day. Still more remarkable are the efforts they are frequently seen to make to supply defects of position. The vine, for example, or the hop, when in want of support, will shoot in the direction of a pole at some feet off, and when the distance has been increased and the direction changed, the plant has been observed still to follow as if guided by a natural will and reason of its own. The tendency observed in plants to follow light, to which we have already referred, is frequently painfully shown in the poor stunted flowers grown in some smoky city attic, where the sickly branches are seen to push off in the one direction as if struggling and gasping for light and air. The following still more remarkable illustration of this tendency is given in the Memoirs of the Boston Academy of Arts and Sciences:—In the spring a potatoe was left behind in a cellar where some roots had been kept during the winter, and which had only a small apperture of light at the upper part of one of its sides. The potato, which lay in the opposite corner of this aperture, shot out a runner, which first ran twenty feet along the ground, then crept up along the wall, and so through the opening by which light was admitted."

Here the discrimination is not between instinct and reason, but between the mere laws of vegetable life and those voluntary motions which are directed in the animal kingdom to the accomplishment of purposes in which foresight and rational design apparently bear no part. Still the very language we employ, with reference to vegetable life, shows how unconsciously we recognise the close affinity between its vital motions and the instincts

of animals. We talk of plants *showing a fondness* for particular spots; of their *choosing* certain aspects and soils; of their *preferring* some localities to others; of their *loving* the light and heat of the summer, and *enjoying* its refreshing showers. All these terms are strictly appropriate, as we find, if we attempt to substitute others in their place. They convey indeed that pleasurable sense of being which we cannot avoid associating with the living plant, in contrast to the inertness and tendency to corruption of the dead tree, or withering flower. Yet in the plant, as well as the animal, we recognise a process akin to the results of our own reason. If the hop plant, while suffering for want of support, reasoned on the matter, it could not conclude more wisely than to shoot out its tendrils after the shifting pole, and if the caterpillar or butterfly shared in all the fruits of butterfly experience since the first one basked amid the flowers of Paradise, it could not act more wisely than it now does in the sunshine of its first day's existence, when it has just passed from the chrysalis state of being.

Various of the senses doubtless serve as guides to these inexperienced instincts, as is shown, for example, by the flesh-fly frequently laying its eggs on the carrion plant, guided thereto apparently by the resemblance of its odour to that of a piece of decaying flesh. Still no argument derived from any such evidence will serve to lessen the distinction between instinct and reason. The new-born infant turns by natural instinct to its mother's breast, and requires no teaching to inform it how to draw the nourishment from thence; and the new fledged insect needs no monitor to direct it in the choice of its food. But it is otherwise with the child, which is appointed to be guided by reason during its years of pupilage, and therefore has no such instinct, but will pluck and eat the tempting but deadly berries of the night-shade far more readily that the ears of ripe wheat which are beside it.

No example of instinct as displayed by insects has excited more attention than that of the bees, which live harmoniously under monarchical rule, divide the various duties of their busy round of labours, and, above all, construct their delicate and ingenious cells with a precision and exactness which the geometrician might seek to rival, but could not surpass. In the intelligent and ably reasoned "Dialogues on Instinct," from the pen of Lord Brougham, the following interesting conversation occurs:—

"*B.* Even upon the principle of necessity, suppose the man and the bee to be equally under the entire control of the premises in reasoning, and the circumstances or motives in willing, whatever it is that each does, be it the necessary consequence of the circumstances or not, is different in the two cases. Suppose that if the bee reasoned she would be under the necessity of drawing the same conclusion, and that if she exercised an election, she could not avoid choosing one course, and that it is the same with the man—it still is not only not proved that the bee does reason or choose, while we know that the man does, but the contrary seems proved.

"*A.* How so? Were I to maintain the contrary I should deny that we have any such proof. How do you prove the negative proposition, that the bee does not reason and will?

"*B.* Observe, I do not say we have the proof of the negative as clearly as we have of the affirmative. But, beginning with laying aside those actions of animals which are either ambiguous or are referable properly to reason, and which, almost all philosophers allow, show a glimmering of reason; and confining ourselves to what are purely instinctive, as the bee forming a hexagon without knowing what it is, or why she forms it; my proof of this not being reason, but something else, and something not only differing from reason in degree but in kind, is from

a comparison of the facts—an examination of the phenomena in each case—in a word, from induction. I perceive a certain thing done by this insect, without any instruction, which we could not do without much instruction. I see her working most accurately without any experience, in that which we could only be able to do by the expertness gathered from much experience. I see her doing certain things which are manifestly to produce an effect she can know nothing about, for example, making a cell and furnishing it with carpets and with liquid, fit to hold and to cherish safely a tender grub, she never having seen any grub, and knowing nothing of course about grubs, or that any grub is ever to come, or that any such use, perhaps any use at all, is ever to be made of the work she is about. Indeed, I see another insect, the solitary wasp, bring a given number of small grubs and deposit them in a hole which she has made, over her egg, just grubs enough to maintain the worm that egg will produce when hatched—and yet this wasp never saw an egg produce a worm—nor ever saw a worm—nay, is to be dead long before the worm can be in existence—and moreover she never has in any way tasted or used these grubs, or used the hole she made, except for the prospective benefit of the unknown worm she is never to see. In all these cases, then, the animal works positively without knowledge, and in the dark. She also works without designing anything, and yet she works to a certain defined and important purpose. Lastly, she works to a perfection in her way, and yet she works without any teaching or experience. Now, in all this she differs entirely from man, who only works well, perhaps at all, after being taught—who works with knowledge of what he is about—and who works, intending and meaning, and, in a word, designing to do what he accomplishes. To all which may be added, though it is rather perhaps the consequence of this difference than a separate and substantive head of diversity,

the animal works always uniformly and alike, and all his kind work alike—whereas no two men work alike, nor any man always, nay any two times alike. Of all this I cannot indeed be quite certain, as I am of what passes within my own mind, because it is barely possible that the insect may have some plan or notion in her head implanted as the intelligent faculties are: all I know is the extreme improbability of it being so; and that I see facts, as her necessary ignorance of the existence and nature of her worm, and her working without experience, and I know that if I did the same things I should be acting without having learnt mathematics, and should be planning in ignorance of unborn issue; and I therefore draw my inference accordingly as to her proceedings."*

In this reasoning the reader will hardly fail to coincide. Yet how wonderful a thing is this instinct, when followed out in all its various manifestations. As to the precise amount of knowledge or design that accompanies such instinctive actions it is difficult, if not indeed impossible for us to form any very definite idea; but we have only to observe how very imperfect and inadequate our own motives frequently are, to arrive at still higher conclusions respecting these. We eat because we are hungry, drink because we are thirsty, sleep because we are weary and exhausted; but how little do we consider that in this eating and drinking we are in reality producing chyle, blood, bone, and muscle, to repair the daily waste of our frame. Our appetites are in truth instinctive desires, though more under the control of reason than those of the lower animals; and we see in both the wonderful provisions of the Creator by which the continuance of each species, and their healthful sustenance and growth are provided for, as it were by the exercise and oversight of a far higher and more comprehensive faculty of reason than any that man is capable of exercising over himself.

* Lord Brougham's Dialogues on Instinct, p. 24.

CHAPTER IX.

EGGS OF INSECTS.

THE germination of seeds, and the generation of insects from their eggs, are both the work of the season of spring, and the latter forms a no less interesting and instructive phaze of the opening year than the former. The minuteness of insects' eggs, and their number and very general diffusion have led to many fanciful ideas regarding their generation. It is a common popular notion, for example, that small insects, such as aphides and the leaf-rolling caterpillars, are generated by what is called a *blight*, or brought by a particular wind. The simple explanation, however, seems to be, that a multitude of these eggs being laid almost simultaneously in autumn, are hatched almost at the same period in spring, and the husbandman is alarmed by their appearance as suddenly as if they had been brought by a single blast of the east wind. Such is the immense fecundity of many insects, that the queen ant of the termites, or common white ant, is said to lay upwards of 86,000 eggs in a single day; and the fecundity of the aphides, though not dependent on the labours of a single queen, is still more marvellous.

The following illustration of the deposition of the eggs of a well known common insect may suffice to illustrate this subject. It is given in the delightful little work, published by the Society for the Diffusion of Useful Knowledge, entitled, "Insect Transformations:"—"The caterpillar of *Lozetœnia Rosana*, which rolls the leaf of the rose-tree, is well known as furnishing the common poetical comparison of 'a worm i' the bud.' Early in autumn the mother insect deposits an irregularly oval patch of yellowish eggs, covered with a cement of the same colour, sometimes upon the branches of the rose-tree, but

more frequently, as we have observed, upon some smooth object contiguous. For several successive seasons, we have found more than one group of these eggs upon the panes, as well as the frame-work, of a window, beneath which a rose-tree has been trained. At present (January 1830) there are two of these groups on one pane, and three on the frame-work; and as each contains about fifty eggs, should they all be successfully hatched, two or three hundred caterpillars would at once be let loose, and, streaming down simultaneously upon the rose-tree beneath, would soon devour the greater number of its buds. As this window faces the east, the sudden appearance of the insects would make it appear not unplausible that they had been swept hither by an easterly wind.

"We found, during the same winter, an extraordinary number of similar groups of the eggs of a leaf-roller on the branches of the gooseberry and red-currant, in a garden at Lee. On some small trees, from two to ten groups of eggs were discovered; and as each group consisted of from thirty to fifty, a caterpillar might have been hatched for every bud. After the severity of the season was over, we had the piece of bark cut off on which these eggs were attached; and though they had been exposed on the bare branches to the intense frosts of 1829-30, they were hatched in a few days after being brought into our study. As the currant trees were not then come into leaf, we had no food to supply them with, and they refused the leaves of all other plants which we offered to them. Had they been permitted to remain on the trees till they were hatched, they would probably have not left a single leaf undevoured. For this spring, at least, those currant bushes will be safe from their attacks, and of course will set at defiance the supposed blighting winds, which no doubt will, as usual, be accused of peopling the adjacent gardens with caterpillars. It may be well to remark, that these caterpillars, when hatched, are scarcely so

thick as a thread of sewing silk, and being of a greenish colour, they are not readily found on the leaves, the opening buds of which they gnaw to the very core."*

The disappearance of insects takes place for the most part equally suddenly, and has in like manner been conveniently attributed to the action of winds. The operation of those laws, however, by which the propagation and continuance of every species of insect, as of higher animated beings, are cared for, equally accounts for their nearly simultaneous disappearance. The great majority of insects have no sooner arrived at complete maturity than they proceed to fulfil the important designs of Providence, on which the reappearance of similar insects in the following season depends, and this done, their work is at an end. Many die almost immediately, and comparatively few, indeed, survive longer than a very few days thereafter. Thus they have no sooner provided the means for the sudden appearance of what is styled a *blight*, in the following season, than, seemingly by an *insect blight*, they themselves are gone.

Some of the alarms created by these sudden appearances of insects are on record, accompanied by a narrative of facts, sufficing to show, not only the serious ravages of which such minute, but numerous assailants are capable of, but also the still greater excitement and alarm to which their sudden appearance can give birth in the ignorant mind. One remarkable fact noted by naturalists who have made the eggs of insects the subject of special observation, is, that the whole eggs deposited in a particular season are by no means invariably hatched the following year. In some cases, on the contrary, they would appear to remain dormant for two or even three years. As, however, it probably sometimes happens, that in a season of peculiar warmth, or one otherwise presenting unusually favourable circumstances for the hatching

* Insect Transformations, p. 20.

of such insect eggs, the whole may be brought to life at once, and hence the alarming appearance referred to. In 1730, a small caterpillar threatened such destruction, not only to the fruit-trees, but to those of the forests of France, that the parliament of Paris published an edict, commanding the people to *decaterpillar* the trees! It would have been easier for them to expel an armed host from their borders, than to get rid of a tithe of these puny assailants, who threatened to strip the trees in spring, and had already blighted the oaks, so that they looked brown as in the sere close of autumn. Réaumur, the naturalist, who had observed the pupæ during the previous autumn, smiled at the impracticable and ridiculous parliamentary edict. Fortunately, however, about the middle of May, a succession of cold rains produced so sudden a diminution of their numbers, that it soon became difficult to find a single specimen.

In the year 1782, a somewhat similar alarm was excited in the neighbourhood of London, by the appearance of the brown-tail moth caterpillar in great numbers. The actual cause of alarm must have been considerable, but the feeling was very greatly increased by the most extravagant exaggerations printed in the newspapers, so that in many parishes subscriptions were raised, and the people employed to cut off the nests at a shilling per bushel. These were publicly burnt under the inspection of overseers, church-wardens, and other parish officials. "At the first outset of this business," says Curtis, "as I was most credibly informed, fourscore bushels were collected in one day in the parish of Clapham." When the extreme minuteness of these insects' nests are considered, the reader may conceive how immense a destruction of life the work of this single day, in one parish, occasioned by the gathering and burning of eighty bushels of their nests. It may also account in some degree for the alarm which then prevailed, so that by some these insects were

regarded as precursors of the plague. The destruction of every kind of vegetation, the starvation of the cattle, and a universal famine were declared inevitable; and public prayers were offered up in some of the churches to avert so dire a calamity. The naturalist, however, could now dispel such foolish illusions, for caterpillars found on forest trees will not touch the herbage of the field, so that no increase in their amount could endanger the latter, and indeed the season passed away without any extraordinary results occurring to justify the apprehensions which had been entertained.

The singular phenomena which attend the succession of insects, illustrate, perhaps, in a more direct and striking way than any other of the results of the laws of reproduction, the providential care which the Divine Governor exercises over the minutest works of his hand. In the great majority of instances the insect-mother is never destined to see her offspring. In very many cases, indeed, her death ensues almost immediately after the deposition of the eggs, which are to lie dormant till called into life by the returning heat of another spring. Yet no parental solicitude manifested by animals higher in the scale of creation can exceed the instinctive care with which the insect provides for the safety of its future offspring, often at the hazard of its own life. The ingenuity displayed by various moths in providing for their future progeny has frequently been commented on; but the daring zeal with which this is frequently accompanied is in no case more apparent than in that of various kinds of moths which seek out the stores of the bee to furnish a supply for their young. In the dusk of the evening various moths may be frequently seen flitting about the entrance to the hive, and occasionally gliding in between the vigilant guards which are usually stationed at the mouth of the hive. This they are the more readily enabled to do, as the bee does not see well, ex-

cept in broad daylight. If, however, the intruder is detected, he pays the forfeit of his life for his temerity; for the watchers immediately give the alarm by a loud and angry hum; the whole hive is quickly in commotion, and the intruder is surrounded and stung to death. When, however, the wary moth has succeeded in effecting an entrance, the chief difficulty is over, as she is generally able to elude the garrison, and effect her purpose, even should the watchers have been alarmed. It is a provident maternal instinct, however, which prompts her to incur all this danger, for neither the wax nor honey possess any attractions for her, although the former is the most suitable of all food for her grubs. Having, accordingly, reached a quiet corner, the moth deposits her eggs in the wax, where, in due time, each is hatched into a grub, which eats its way by a winding tube through the wax, lining it, as it progresses, with a silken web, which the sting of the bee cannot pierce. Such are the ravages of these parasites, that the entire labours of the industrious bee are sometimes defeated by them, and the hive abandoned by its rightful owners.

There are, however, some examples of the hatching of insect eggs under circumstances somewhat analogous to the maternal care of birds. The wolf-spider, for instance, carries about her eggs in a bag or case, displaying the most earnest solicitude for its preservation, and apparently losing all sense of personal danger in the anxiety to protect her eggs from injury. When violently deprived of her eggs, instead of attempting to escape, she stops to look about, and searches on every hand for them, with an earnestness of purpose apparently in no degree inferior to the solicitude displayed by a hen for her chickens. The French naturalist Bonnet gives the following extremely interesting account of his own observations on this subject:—" With a view to put this singular attachment to a novel test, I one day threw a spider

with her eggs into the pit-fall of an ant-lion. The spider endeavoured to escape, and was eagerly remounting the side of the pit, when I again tumbled her to the bottom, and the ant-lion, more nimble than the first time, seized the bag of eggs with its mandibles, and attempted to drag it under the sand. The spider, on the other hand, made the most strenuous efforts to keep her hold, and struggled hard to defeat the aim of the concealed depredator; but the gum which fastened her bag, not being calculated to withstand such violence, at length gave way, and the ant-lion was about to carry off the prize in triumph. The spider, however, instantly regained it with her mandibles, and redoubled her endeavours to snatch the bag from her enemy; but her efforts were vain, for the ant-lion, being the stronger, succeeded in dragging it under the sand. The unfortunate mother, now robbed of her eggs, might have at least saved her own life, as she could easily have escaped out of the pit-fall; but, wonderful to tell, she chose rather to be buried alive along with her eggs. As the sand concealed from my view what was passing below, I laid hold on the spider, leaving the bag in the power of the ant-lion. But the affectionate mother, deprived of her bag, would not quit the spot where she had lost them, though I repeatedly pushed her with a twig. Life itself seemed to have become a burden to her, since all her hopes and pleasures were gone for ever."*

It is also found that the spider can recognise its own eggs from those of another of the same species; for if, while she is thus solicitous about her lost treasure, the egg-bag of another spider is put before her, the mother remains indifferent to it, and continues her anxious search for her own.

Amid the minute wonders and beauties of nature which the microscope reveals to us, there are none more sur-

* Bonnet, Œuvres, vol. ii., p. 435.

prising than the extreme beauty of form and symmetrical arrangement of these minute clusters of insect eggs, which, to the naked eye, present but a plain unattractive speck. The eggs of the angle-shades moth, for example, bear a close resemblance to the well-known beautiful crustaceous shells called sea urchins, when deprived of their spines. Others are covered with a minute honey-comb or net-work; while in others a curious variety of mechanical contrivances are apparent, as in that of the common louse, which, when seen under a strong magnifying glass, is found to be provided with a hinged lid or door, for the escape of the larvæ.

This wonderful department of animated nature, at which we have thus hastily glanced in this chapter, would furnish abundant materials for the whole volume. We see in it that nothing is too minute to escape the watchful and beneficent care of Providence. Not only does God clothe the grass of the field, but every blade of it teems with life, or sustains the seeds of its future development, in forms of rarest beauty, and possessed of mechanism which puts to shame the most elaborate products of human ingenuity.

CHAPTER X.

PARASITE INSECTS.

The reader's attention has been already directed, in the outset, to the difficulties and apparent discrepancies, as well as to the important disclosures of truth and beauty, which lie open for our study in the Book of Nature; and we think it will be received by the judicious reader as a service, and not as a drawback to the value of these pages, if we exhibit Nature thus, as it actually is, and not

merely selected phases of it, in so far as they may be found to adapt themselves to a preconceived idea. If we go out in the season of early spring, while the first motions of the sap are beginning to be felt under the hard rind of the forest trees, and the swelling of the young buds is scarcely apparent, it will yet be found that it is impossible to pluck a dry twig from the hedge-row, or a branch from the gnarled oak, without finding it covered with the germs of insect life. While all Nature seems dead, and the icy chains of winter are reluctantly giving way, there is in reality a provision for boundless life and joy, safely garnered amid all that seeming lifelessness and restraint. But at the same time it cannot but have struck the thoughtful student of Nature, how little of all this is destined to reach maturity! It does not strike us with any sense of pain, or any idea of incompleteness, that of all the healthful acorns annually cast from the giant oak of the forest, or of mast from the graceful beech, though each containing the living germ of a healthful tree, not one of a thousand is destined to take root and accomplish what might seem the apparent purpose of its creation. On the contrary, we see them suffice by the thousands to feed swine, or squirrels, or field-mice, or uselessly to rot and perish on the ground. Nay more, we are well content, with the cereal grains, to see the annual produce of a thousandfold of corn, and barley, and wheat, with no view to the further development of the living germ which each contains, but to the application of its stores of starch and sugar to uses as different as those for which the unconscious bees are labouring while storing honey for their future progeny.

Such is the state of things throughout the whole vegetable kingdom; and we are accustomed to look upon it without regarding its results as in any great degree anomalous, or apparently contradictory of the means and ends of creation. When, however, we find precisely the

same laws governing the animal kingdom, from the very lowest to the highest forms of development of animated life, they appear accompanied by phenomena which are more difficult to reconcile with our ideas of a perfectly benevolent and all-wise Creator. An examination of them in this view must at least force on us the conviction of how inadequate are all our attempts to solve the mysteries of Providence, and, with finite understandings, to comprehend the Infinite. "His ways are not as our ways, neither are His thoughts as our thoughts."

The same abortive results which are so manifest in the vegetable kingdom become apparent in insect and animal life. By far the larger portion of insect eggs suffice only to produce grubs to feed the birds, or to nourish the larvae of other insects. A universal war seems to prevail, by which life springs from death; and a superfluity of existence in one form suffices to sustain it in others, and thus to preserve the needful balance of the whole. In no instances is this more apparent than in those parasitic insects which instinctively provide for the future sustenance of their offspring at the cost of the life of their sustainer. The moths already referred to, which invade the hive for the purpose of depositing their eggs in the wax, belong to this class. The carnivorous wasps are also exposed to an equally insidious foe in the common ichneumon fly. Sometimes, like the moth, the ichneumon ventures to enter the wasp's nest before it is completed, but more frequently it waits till the wasp has completed its maternal labours, depositing its eggs, and storing in a sufficient supply of caterpillars for its young. When this is finished, the mason-wasp completes its labours by closing up the entrance with a strong barricade of kneaded clay: this, however, is no protection against the assaults of the ichneumon fly. In addition to its long ovipositor, with which its eggs can be inserted into a narrow and deep hole, it is provided with a toothed

borer, with which, in about a quarter of an hour, it can pierce through the strong outworks of the wasp's nest. This done, the long ovipositor is inserted, and the egg of the ichneumon fly takes the place of the wasp grub, surrounded with the coil of caterpillars which the instinct of the parent wasp had stored up for it.

Still more remarkable are the various instinctive provisions manifested in those cases where the actual living body of the caterpillar is selected for the place of deposit of these parasite eggs, and its life is converted into a means of nourishment and sustenance of a whole family of the enemies of its race. "It must have occurred," remarks the author of the interesting work entitled "Insect Transformations," "to the least attentive observers of the very common cabbage caterpillar, that when it ceases to feed, and leaves its native cabbage to creep up walls and palings, it is often transformed into a group of little balls of silk, of a fine texture, and a beautiful canary yellow colour; from each of which there issues, in process of time, a small four-winged fly, of a black colour, except the legs, which are yellow. By breeding these flies in a state of confinement, and introducing them to some cabbage caterpillars, their proceedings in depositing their eggs may be observed. We have more than once seen one of these little flies select a caterpillar, and perch upon its back, holding her ovipositor ready brandished to plunge between the rings which she seems to prefer. When she has thus begun laying her eggs, she does not readily take alarm, but, as Réaumur justly remarks, will permit an observer to approach her with a magnifying glass of a very short focus. Having deposited one egg, she withdraws her ovipositor, and again plunges it with another egg into a different part of the body of the caterpillar, till she has laid in all about thirty eggs. It is not a little remarkable, that the poor caterpillar, whose body is thus pierced with so many

wounds, seems to bear it very patiently, and does not turn upon the fly, as he would be certain to do upon another caterpillar, should it venture to pinch him—a circumstance by no means unusual. Sometimes, indeed, he gives a slight jerk, but the fly does not appear to be at all incommoded by the intimation that her presence is disagreeable.

"The eggs, it may be remarked, are thrust sufficiently deep to prevent their being thrown off when the caterpillar casts its skin; and, being in due time hatched, the grubs feed in concert on the living body of the caterpillar. The most wonderful circumstance, indeed, of the whole phenomenon, is the instinct with which the grubs are evidently guided to avoid devouring any vital part, so that they may not kill the caterpillar, as, in that case, it would be useless to them for food. When full grown, they even eat their way through the skin of the caterpillar without killing it, though it generally dies in a few days, without moving far from the place where the grubs have spun their group of silken cocoons in which to pass the winter."*

Still more curious is the selection by many insects of the eggs of other insects for depositing their own in. By this many spiders' eggs fall a prey to the larvae of various small flies, which deposit their eggs into or among those of one of the chief enemies of their race, and thus may be said to take a most ingenious revenge on their foe. "Out of the eater comes forth meat;" and these eggs of the spider are subsequently feasted on by the progeny of the fly which spring from these parasite eggs.

It thus seems that, amid all the wondrous multiplicity of life and beauty, to which the microscope has added so much additional evidence, in the insect kingdom, death and destruction no less abundantly reigns. Nor is it accidental, or a non-essential element, introduced appa-

* Insect Transformations, p. 61.

rently like the wars or strifes of men, by some lawless excess of passion, or chance combination of events, apart from the original provisions of the Creator. It is manifestly the fruit of laws on which the whole perpetuity of animate and inanimate life depends, and is part of the destined means provided by the inscrutable wisdom of the Great Lawgiver of the Universe. Yet this also is under his control. We perceive in the occasional partial occurrence of insect blights, like the great Egyptian plague of flies, what would be the result, in a single season, if every insect egg came to maturity. The caterpillar would eat up every green leaf; the barrenness and sterility of winter would take the place of summer; the season of autumn would come round without its harvests; the animal kingdom, and man himself, would perish by the excess of insect life; and it also, deprived of the food by which its progeny must be nurtured in their immature state, would perish in the universal wreck.

Here, then, we perceive, in a very remarkable manner, the evidences of an overruling Providence controlling laws for the harmonious balance of life and enjoyment amid the countless multitudes of his dependent creatures. Some of these laws may appear to our minds to involve results which it is difficult to reconcile with our own ideas of perfection. But how inadequate must our finite understandings be to conceive of a standard by which the Infinite shall be tested in his dealings with the works of his hands; and how incumbent is it, therefore, for us to learn in these the lessons of humility, which every new discovery in nature, and art, and science, seem calculated to teach us. We are but of yesterday, and know nothing.

CHAPTER XI.

GALL-FLIES.

In so comprehensive a subject as the science and revelations of the seasons, it is but a small part of the vast field that can be overtaken in a work like this. The theme, indeed, is inexhaustible, and, for its adequate elucidation, demands a knowledge of all sciences, and a reference to every department of the works of nature. It will suffice, however, for our present purpose of tracing out a few of the ample pages of the Book of Nature, to select a few of the most striking illustrations from each department. In the ichneumon fly we see the instinct of the mother selecting a safe deposit for her egg, where, without labour of her own, an abundant supply of food is already stored up for its future use. We also recognise in the whole process a curious example of the controlling influences by which the reproductive instincts react and keep in check the excessive multiplication of those which would become noxious and destructive if in excess. The mason wasp having, with much labour and skill, excavated her nest in the compact sandbank, and deposited her egg in the bottom, next collects about a dozen of full grown caterpillars, which she places one above another over the egg, so as to supply abundant sustenance to the future wasp-grub. But the ichneumon fly defeats all these sagacious provisions by an equally provident maternal instinct. Its egg is inserted at the very bottom of this nest which the mason wasp had sealed up so securely, and the grub which springs from the intruded egg devours indiscriminately that of the wasp and the caterpillars so industriously provided for its maintenance. Thus strangely does instinct counterwork with instinct, while the supreme and overruling power is still apparent, checking and controlling

all, and preserving order and harmony amid the infinite and apparently conflicting varieties of nature.

We shall now, however, consider another class of parasitic insect eggs, which secure the needful sustenance of the embryo insect without preying on their rivals, and which have an additional interest for us, as producing an article of commercial value, employed in medicine, and extensively used in the arts. The most superficial observer must have frequently noticed, during country rambles, the curious and not inelegant excrescences to be seen on various trees, but chiefly on the leaves and branches of the oak. During the vigorous season of vegetable life, a puncture in the leaf or branch of a tree is followed by an exudation of the sap, accompanied by a peculiar growth, somewhat resembling that restoring process by which a wound or scar is healed over in the animal frame. A class of insects, known by the name of gall-flies, are taught, by a remarkable instinct, to make use of this property of vegetable life for the protection and sustenance of their own eggs and larvæ. For this purpose they are provided with a natural instrument, bearing considerable resemblance to the ovipositor of the ichneumon already described. This instrument varies in different members of the gall-fly family, appearing in some a conspicuous feature at all times, while in others it is drawn up and nearly concealed, like the sting of a bee when in repose. Like the ovipositor of the ichneumon, it is considerably longer than the whole body, and is bent up in a remarkable manner within it when at rest. With this instrument the gall-fly punctures the leaf or bark of the tree selected for the deposition of her egg, and inserting the egg within the opening, it is supposed that she drops upon it an adhesive or glutinous liquor, which expands with the flowing sap without admitting of its escape, and after attaining to its full distension, it solidifies into the vegetable gall, hemming in the egg within its living walls.

The little bulbs, or galls, thus produced, are graceful and pleasing objects, sometimes possessed of considerable beauty, and in no case offensive, or apparently in any degree injurious to the tree. In their simplest and most common forms, the rambler in the country may observe them in great numbers on the leaves of the oak, the poplar, the willow, and many other trees. Indeed, it is scarcely possible to break off a small twig of oak, on some of the leaves of which the gall does not occur. It resembles a small green berry, about the size of a currant, adhering to the leaf, and occasionally varied with a reddish tinge. So entirely does it appear a natural vegetable product, though seemingly an irregular excrescence, that no one, without examining and watching its origin, would think of tracing it to its insect originator, any more than they would think of ascribing the acorn or the rose-hip to such a source. When, however, the gall is cut open, it presents a firm, juicy, thick rind, with a hollow in the centre, which either contains the egg, or, later in the season, the little grub, thus safely and comfortably housed by this singular instinct of the parent gall-fly. It is, moreover, surrounded by an abundant store of food, the soft, pulpy rind of the gall being that on which it feeds until it is ready to pass into its winter sleep, preparatory to another change, when it becomes the fully matured gall-fly, itself endowed with the same marvellous instincts for thus providing for the continuance of its species, and the housing and maintenance of its young.

The gall-insects, which produce these curious vegetable excrescences, are of various kinds, some of them belonging to the tribe of aphides; and an equal diversity prevails in their nests, as well as in the choice of the plant or tree on which they are produced. Besides the large forest trees already mentioned, they occur on the rose-tree, the ground-ivy, the thistle, the germander, and,

indeed, on many other plants. Even on the same tree the galls of more than one species of insect occur. On the oak, for example, besides the small galls already described on the leaf, it is usual to find at the extremity of some of the branches a growth somewhat larger than a filbert, also formed by means of the exuding sap, and designed to afford an efficient protection and storehouse for a family of young larvae. The oak-apple, as one of the oak galls is commonly termed, is frequently as large as a walnut, and bears considerable resemblance, both in colour and texture, to a ripe apple. This contains, not one, but a whole family of larvae, each inclosed in its little, oval cell, and surrounded with a sufficient supply of the juicy food adapted to its wants.

It is the gall-nut of a species of oak, the *Quercus infectoria*, a tree abounding at Aleppo and Smyrna, which forms so important an article of commerce, and, among other uses, is largely employed in the manufacture of ink. Galls are also brought in considerable quantities from Syria and Cyprus, and are produced by an insect called the Cynips Quercus, which deposits its ova in the bud. Buds which have been thus impregnated, instead of elongating and growing into branches, expend their whole juices in forming the large globular gall-nut which constitutes the fit nidus for the future larvae.

Another remarkable and exceedingly beautiful variety of the product of the gall-fly, is that which commonly occurs on the rose-tree, presenting to the eye the appearance of a fine red tuft of moss. This also is the nest of a considerable group of larvae, and as at the deposition of each egg an exudation of sap takes place, a much larger growth is produced than in the case of those gall-flies which only deposit one egg at a time. The appearance of the rose-tree gall, or *bedaguar*, as it is called by naturalists, is altogether singular. In this case, the insect deposits a group of eggs together around the chosen spot on a branch of

the wild rose-tree, and the singular and beautiful product curiously illustrates the combined action of the insect, and of the natural results of vegetable vitality diverted into an unusual channel. The sap flows in great abundance from each wound made in the bark, and the growth, which constitutes the nest of the eggs and future grubs, swells to a large bulb, frequently as large as a crab-apple, and containing a series of cells, in each of which lies the embryo of the future grub. But the most remarkable characteristic of the *bedaguar* is its outer covering. The sap, which exudes so freely, instead of being evaporated by the heat of the sun, or washed away, shoots up into a reddish-coloured fibre, covered all over with little tufts of hair or moss, closely resembling that which forms the peculiar characteristic of the flower-bud of the moss-rose, and giving to the whole the appearance of a large tuft of reddish-brown moss adhering to the branch. In this curiously-constructed mansion the grubs live throughout the winter, each lodged in its little globular cell, and the thick covering of warm mossy tufts of red fibres is no doubt as useful as it is ornamental, sufficing to shield the nest from the severity of the winter frosts and chill winds, and to preserve the well-housed grubs in sufficient warmth, until the return of milder seasons prepares them for another change. Before this takes place the *bedaguar* has grown as hard as the toughest wood of the rose-tree, so that it can be cut with difficulty with a knife. The genial heat of the returning spring, however, awakens the dormant vitality of the grub, and having feasted on the softer pulp within, it eats its way through the hard outer wall of its cell, and, under the influence of the summer's heat, undergoes its final change into a winged insect.

It is not necessary that we should direct the attention of the intelligent reader to the curious evidence of contrivance and design apparent in the adaptation of the various

gall-insects to their peculiar modes of depositing their eggs, and providing for the future sustenance and final transformation of their young. Whether we turn, with the telescope, to the vast profundities of stellar space, or, with the microscope, to the minute animalcules, whose little world is comprehended in a leaf or a single blade of grass, we find not only the proofs of an inexhaustible wisdom and fertility of design, but, even if we select one single and apparently insignificant species of insects, such as the gall-flies which we have just described, we find an amount of ingenuity and elaborate design expended on the provision for all their instincts and wants, such as would exhaust the wisdom of man, when brought to bear on the highest purposes of his ambition. The unerring instinct of each variety of these little flies guides it to its own peculiar leaf, branch, or bud, precisely as though the winged insect treasured in thought all the proceedings, from the first deposition of the egg whence it was produced, till it emerged from the gall a perfect winged insect, to fulfil the same instincts of its nature. Mr. Rennie has described the remarkable instrument by which the little insect effects such curious results in his work on "Insect Architecture." In some insects the *ovipositor* is conspicuously long, even when the insect is at rest, as in the ichneumon fly, already described in a previous chapter; "but in others, not above a line or two of it is visible till the belly of the insect be pressed. When this is done to the fly that produces the currant-gall of the oak, the ovipositor may be seen issuing from a sheath in the form of a small curved needle, of a chestnut-brown colour, and of a horny substance, and three times as long as it at first appeared. What is most remarkable in this ovipositor is, that it is much longer than the whole body of the insect in whose belly it is lodged in a sheath, and, from its horny nature, it cannot be either shortened or lengthened. It is on this account that it is bent into the

same curve as the body of the insect." The mechanism by which such a peculiar combination of strength and compactness is produced, has been compared to that seen in the tongue of the wood-pecker, which has the bone at its root, so thin and elastic, that it can be rolled up like the spring of a watch. Its admirable adaptation to the maternal instincts of the insect, are nowhere more apparent than in its insertion of its eggs into the living body of the caterpillar, not only without injuring any vital part, but apparently without causing pain to the caterpillar whose further transition is by this means arrested, and its life rendered subservient solely to the offspring of its destroyer. Naturalists have accordingly assigned to the pupivora, or second great class of hymenopterous insects, to which the ichneumon belongs, the special purpose in the economy of creation of preventing other tribes of insects from becoming too numerous.

The caterpillar for example, the ravages of which may be so frequently observed on cabbages, may be observed at certain seasons in considerable numbers on the garden wall, where they select some sheltered nook under the coping, or in any accidental crevice of the plaster, and attach themselves to the spot preparatory to their undergoing transformation into the pupa state. The caterpillar referred to is that of the common white butterfly. One of these may be frequently seen to select its retreat in this manner, and attach itself to the wall by means of the silken threads which it spins. To all appearance it is in a perfectly vigorous and healty state, but if watched, instead of changing into a chrysalis, it will be seen in a short time covered with a number of small yellow silken cocoons spun by the larvæ of the ichneumon, its insidious foe, which, after being nourished at the cost of its life, have eaten their way through its skin, preparatory to their own transformation. In many cases, however, the ichneumon's eggs are not hatched until after the cater-

pillar has undergone the change into a chrysalis. But this in no degree affects the final results. The eggs are hatched within their living nest, feed there on the contents of the pupa case, enclose themselves in their silken cocoons, and only eat their way through the chrysalis case after they have undergone their final transformation: presenting a remarkable example of a living resurrection apparently from a dead body.

CHAPTER XII.

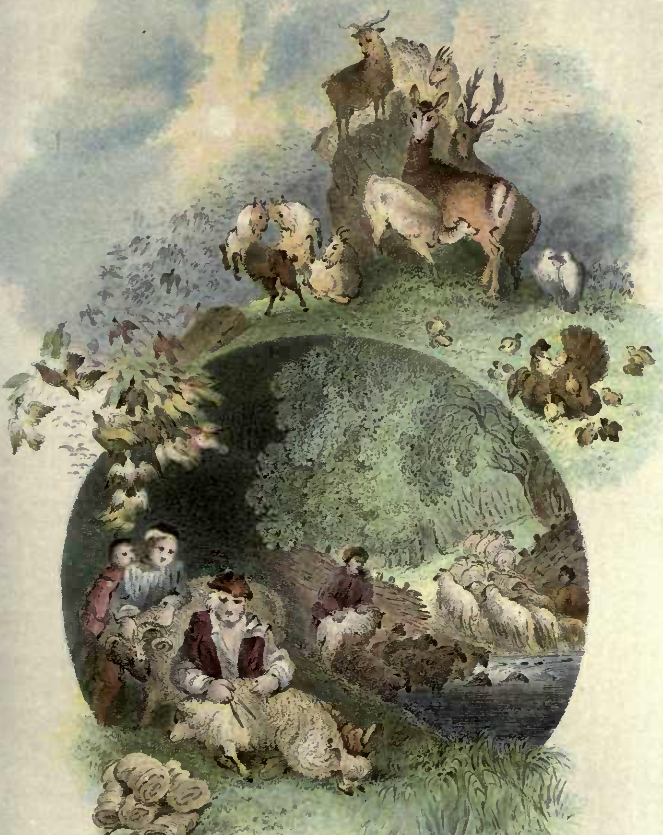
PAIRING OF BIRDS.

THE poet Cowper, in one of the lively and ingenious fables which he penned as the pastime of some of his leisure hours, represents under the title of "Pairing-time Anticipated," an assembly of the birds on a warm and bright winter's day, resolved to take advantage of the mildness of the season and anticipate the coming spring. The youthful birds, in their first full-pledged season, are all wondrously taken with the project, and reject with scorn the advice of an experienced Bulfinch

Who could boast
More years and wisdom than the most.

The consequence is that the whole feathered tribe, proceed as wiser human beings too often do, setting all experience at defiance, and refusing to be guided by any advice which runs counter to their own inclinations and wishes. The results were soon sufficiently apparent:

All pair'd, and each pair built a nest.
But though the birds were thns in haste,
The leaves came on not quite so fast,
And Destiny, that sometimes bears



SPRING & SUMMER.

An aspect stern on man's affairs,
Not altogether smiled on theirs.
The wind, of late breath'd gently forth,
Now shifted east, and east by north:
Bare trees and shrubs but ill, you know,
Could shelter them from rain or snow,
Stepping into their nests, they paddled,
Themselves were chill'd, their eggs were addled;
Soon every father bird and mother
Grew quarrelsome, and peck'd each other,
Parted without the least regret,
Except that they had ever met,
And learn'd in future to be wiser,
Than to neglect a good adviser.

The results of human rashness and folly thus humourously pictured in the experience of the feathered tribes, are frequently of so mischievous and disastrous a nature that it might seem desirable with thousands to have the unerring instincts of the lower animals substituted for the rational faculties which are possessed by them to so little purpose.

Such unseasonable excesses, however, though sufficiently common in the experience of men, are altogether unknown among the lower animals. No mild winter ever tempts the finch or the robin to build its nest, or awakens the inharmonious music of the cawing rookery, to call its inmates to the social work of spring. The birds which flit about the leafless woods throughout the winter, remain as indifferent to the whole proceedings connected with the reproductive functions and instincts, as the whole tribe of insects, then cradled in their silken cocoons and chrysalis cases. But no sooner does the proper season approach than a total change is apparent. Though the chill of winter still lingers, and the increasing warmth of the sun's rays are only very partially perceivable, a complete regeneration of nature seems already begun. The sap is rising in the dry and dead-like branches, the buds are beginning to swell, and their hardened dry scales to expand and make way for the growth of the tender leaf;

the frost-bound clod is thawing, and the soft buds, and seeds, and roots within, are quickening into life. Soon the bare branches of the forests and hedge-rows are to be clad in the green livery of spring, and the whole feathered tribes, as if in anticipation of this change, are making joyful preparations for the season of love. This is the period when the feathered songsters are in full note, and many birds which are silent or rarely heard at other seasons, now enliven the period of the opening year with their cheerful invitation to their mates. The pairing of birds, while it lasts, has something so much akin to the social and domestic duties and affections of the human race that they excite a sympathy such as we cannot extend to other animals.

Among insects, such as we have been considering, as well as among the greater number of quadrupeds, the male bears no share in the parental duties of rearing or providing for the young; and even among those associated insects, such as the bees and ants, where the care of the young, and the provision for their future sustenance and maturity, occasion so much labour and solicitude, the duty appears to be devolved on a separate caste, ignorant alike of paternal instincts or maternal affections, though furnishing in their instinctive zeal the full equivalent of both.

With the earliest indications of approaching spring each feathered songster is seen to seek its mate, and the pair thus associated together, generally remain faithful to each other, until they have reared a young brood, and seen them fledged, and perfectly capable of providing for their own subsistence; nor indeed is the union always limited to the single season. Many birds have been known to return year after year, and repair and occupy the same nest. In a wood in the neighbourhood of Cumbernauld House, Dumbartonshire, in the vicinity of some extensive lime quarries, a pair of magpies were observed to build in

a large beech tree for several successive years, and one of the birds having been caught and marked, it was seen to return to the same nest for six successive seasons thereafter, most probably also with the same mate. Mr. Rennie has noted another magpie's nest which continued thus successively occupied, season after season, for ten years, and though a brood of four or five young ones was reared each season, all of them disappeared from the neighbourhood, as if recognising it as the exclusive property of the old pair.

There is something exceedingly lively and pleasing in the cheerful notes of birds in the spring time. However unmusical their voices may be, their notes convey so much the idea of industrious happiness and the full enjoyment of life, that few indeed will fail to derive pleasure from the sounds. The twittering of the swallow, the chirp of the sparrow, and even the incessant cawing of the rook, seem all to harmonize with the reviving life of nature, and to add a new charm to the season of spring. "The swallow," for example, Sir Humphry Davy remarks, "is one of my favourite birds, and a rival of the nightingale; for he glads my sense of seeing, as much as the other does my sense of hearing. He is the joyous prophet of the year, the harbinger of the best season; he lives a life of enjoyment among the loveliest forms of nature; winter is unknown to him, and he leaves the green meadows of England in autumn, for the myrtle and orange groves of Italy, and for the palms of Africa." The migratory habits here referred to and which are common to so many of the birds that visit us in the spring, add another remarkable feature to the fact of their return, year after year, to the same locality. It is, indeed, scarcely possible to conceive of a more marvellous and unerring instinct than that which guides the little swallow, or the less powerful lark, back over nearly a quarter of the globe, returning unerringly at the appointed season, and

finding its way over land and ocean, to the precise spot in the old tree or meadow, or under the sheltering eave where its nest has been renewed from year to year.

The comparison which has been drawn between the attachments shown in the pairing of birds, and the affections of the human species, is borne out by many striking corroborations, but in no case is it more markedly apparent than in the pigeon tribe. This natural family of birds, comprising the pigeons, doves, and turtles, is found, with very few exceptions, to be gregarious, living together both in the wild and domesticated state, in large flocks. When, however, the season of love approaches, they pair together, and the male and female continue thenceforth to manifest a degree of attachment and mutual fidelity, the strength and ardour of which have long been proverbial. They work jointly in the construction of the nest, and after this preparatory work has been completed, and the female has laid her eggs, each takes by turns the charge of the nest during incubation, and share alike in the nurture and rearing of the young. Contrary to the natural habits of most other birds, pigeons lay only two eggs at a time, and when the young pigeons have been hatched and reared so as to be able to take care of themselves, the faithful pair, instead of separating, as is usual with the feathered tribe, maintain their attachment, and repeatedly incubate during the year. There is something peculiarly winning in the gentle cooing of the pigeon to its mate; while, when the two are together, they are seen frequently putting their bills together like two amorous lovers, and consorting themselves with such evident symptoms of mutual affection that the phrase "billing and cooing" has come to be a familiar one in reference to the fond dalliance of lovers.

The great difference in the hatching of insect eggs, contrasted with those of birds, as well as the nature of the wants of young birds and the means of supplying them,

compared with the offspring of quadrupeds, abundantly account for the fidelity to the parental duties thus peculiarly manifested by birds. The labour of building the nest requires the conjoint aid of the male and female; and when this ingenious structure has been completed, and the eggs disposed on its soft lining, they would, in most cases, perish were the female unrelieved in brooding. But it is not a mere share of labour that is undertaken by the feathered pair; the affectionate interchange of attention is manifested in the most engaging ways. Sometimes the male is seen to bring food to the brooding hen; at other times he perches himself on a neighbouring bough, and solaces her with his cheerfulest and sweetest notes. Then he will take her place and continue the maternal duties, while she roams abroad for a short time in search of needful food and exercise.

The perseverance and instinctive ingenuity of birds in the building of their nests is no less admirable than some of those remarkable evidences of creative wisdom in relation to insects which have already been referred to. Among familiar instances of the ingenuity of the feathered tribe, the nest of the song-thrush is well deserving of selection. The parent birds, having selected a convenient spot on the branch of a tree, proceed to lay their foundation with moss or fine fern. Into this they weave grass and straw, or root-fibres, twining them together, and interlacing the raised sides like a piece of basket-work. The interior is then shaped by the breast of the animal into a neat and uniform hollow, not unlike a breakfast tea-cup, and by means of a cement, composed chiefly of decayed wood, mixed with their own saliva, the whole is cemented internally, so as to be perfectly smooth and water-tight, and as regular as if finished on a turning lathe. In this dry and hard bowl the eggs are laid, without any softer lining, so that, when the nest is hastily moved, or shaken by the wind in the absence of the parent birds, the

eggs may be heard to rattle on the sides. The song-thrush displays considerable diversity of taste in the choice of a place for building its nest, choosing sometimes a tall fir-tree, at others a holly or hawthorn bush, and sometimes even a furze bush, or the tall grass on a raised fence. It has also been observed, in some few instances, to build in an ivied wall, or in an outhouse.

In the third volume of the Magazine of Natural History, an interesting example of the latter choice of a building-place is thus referred to:—" A wheel-wright had been employed in making a thrashing-machine for a farmer in the neighbourhood of Pitlessie in Fife, and had three of his men along with him. They wrought in a cart-shed, which they had used for sometime as their work-shop; and one morning they observed a mavis (thrush) enter the wide door of the shed, over their heads, and fly out again after a short while; and this she did two or three times, until their curiosity was excited to watch the motions of the birds more narrowly; for they began to suspect that the male and female were both implicated in this issue and entry. Upon the joists of the shed were placed, along with some timber for agricultural purposes and old implements, two small harrows, used for grass-seeds, laid one above the other; and they were soon aware that their new companions were employed with all the diligence of their kind in making their nest in this singular situation. They had built it, he said, between one of the butts of the harrow and the adjoining tooth; and by that time, about seven o'clock, and an hour after he and his lads had commenced their work, and the birds had made such progress, that they must have begun by the break of day. Of course, he did not fail to remark the future proceedings of his new friends. Their activity was incessant; and he noticed that they began to carry mortar which he and his companions well knew was for plastering the inside. Late in the same afternoon,

and at six o'clock next morning, when the lads and he entered the shed, the first thing they did was to look at the mavis's nest, which they were surprised to find occupied by one of the birds, while the other plied its unwearied toil. At last the sitting bird, or hen, as they now called her, left the nest likewise; and he ordered one of the apprentices to climb the baulks, who called out that she had laid an egg; and this she had been compelled to do some time before the nest was finished; only plastering the bottom, which could not have been done so well afterwards. When all was finished, the cock took his share in the hatching; but he did not sit so long as the hen, and he often fed her while she was upon the nest. In thirteen days the young birds were out of the shells, which the old ones always carried off." *

A very great diversity is apparent in the choice of materials for the nests even of our commonest native birds, so that the naturalist can tell by the nest, as readily as by the eggs, the character of the little builders. Grahame, the Scottish poet, gives interesting and minute descriptions of those in his "Birds of Scotland." The yellow-hammer, for example, a bird common in Scotland, combines in its ingenious process of nest-building the basket-work of interweaved roots and grass for the exterior, and the felting with soft moss, hair, and wool in the inside. The usual site of its nest is in the hedge-row, or in some low bush; but it also frequently builds among tufts of reeds, or in the mossy clumps on the broken banks of a stream. The poet thus refers to its native habits in the spring:—

> "Up from the ford, a little bank there was,
> With alder-copse and willow overgrown,
> Now worn away by mining winter floods;
> There, at a bramble root, sunk in the grass,
> The hidden prize, of withered field straws formed,
> Well lined with many a coil of hair and moss,
> And in it laid five red-veined eggs, I found." †

* Mag. of Nat. Hist., vol. iii., p. 238.

† Grahame's Birds of Scotland, p. 26.

Were we to examine the ingenious arts of the nest-builders of various countries, we would find a theme of interest which would require volumes to exhaust it. The instincts by which insects provide for the safety of their progeny are in no degree more remarkable than those of the feathered tribes. The tailor-bird of Hindostan, for example, gathers cotton from the shrubs, spins it to a thread by means of its feet and long bill, and then employing its bill as an awl, it sews the large leaves of an Indian tree together so as to protect and conceal its young. Cotton, as an article of manufacture, is quite of modern introduction to Europe, yet long before the capabilities of this invaluable plant had been discovered by us, the instinct of this little bird had guided it to its use, and the cotton thread was annually employed in the completion of its nest. The remarkable structures reared by the sociable grosbeak must be familiar to most readers from the numerous engravings of them which exist. They appear like a great bird city, having many approaches, each with the nests constructed under the eaves, as in a covered passage, neatly built of what is called the Boshman's Grass, so firmly basketed together as to be impervious to rain. Another species, the pensile grosbeak, suspends its curious pendent nest from the end of the branch of a tree, generally over water, and with the entrance by means of a long cylindrical passage from below. The little builder is only about the size of our common sparrow, yet this pendent passage to its nest frequently measures fifteen inches long. Another remarkable example of a similar class of nests is furnished by the Indian toddy-bird, or baya, thus described by Forbes:—"The baya, or bottle-nested sparrow, is remarkable for its pendent nest, brilliant plumage, and uncommon sagacity. These birds are found in most parts of Hindostan; in shape they resemble the sparrow, as also in the brown feathers of the back and wings; the head and breast of a bright yellow, and

in the rays of a tropical sun have a splendid appearance, when flying by thousands in the same grove; they make a chirping noise, but have no song; they associate in large communities, and cover extensive clumps of palmyras, acacias, and date-trees with their nests. These are formed, in a very ingenious manner, by long grass woven together in the shape of a bottle, and suspended by the other end to the extremity of a flexible branch, the more effectually to secure the eggs and young brood from serpents, monkeys, squirrels, and birds of prey. These nests contain several apartments, appropriated to different purposes: in one the hen performs the office of incubation; another, consisting of a little thatched roof and covering a perch, without a bottom, is occupied by the male, who, with his chirping note, cheers the female during her maternal duties."

The object of these ingenious builders appears to be to protect their young against squirrels, serpents, and numerous other deadly enemies, against whose force they thus oppose a more effective defence than superior strength and watchfulness could furnish.

We need not, however, seek among the rare and curious arts of foreign nest builders for evidence of such varied ingenuity. Abundant proofs of the diversified instincts of the feathered tribes are furnished within our own reach on every returning spring. The window and chimney swallow may be called our native mason-builders, and their works are familiar to all as the pleasant evidences of the reviving year. The chaffinch, goldfinch, and other felters among British birds display the ingenious fruits of this department of work; and even the loose structure of the house-sparrow is not without value. It is, indeed, a subject of considerable interest in reference to the entire question of instinct, the curious modifications of the natural habits of animals produced even by the proximity of man. The stork, the house and chimney swal-

low, and the sparrow, for example, appear to have had their original instructive habits partially modified merely by the vicinity of man, without any domestication, as if they had been created with a natural aptitude for partaking of facilities created by our progressive civilization. The common house-sparrow sometimes builds in holes of walls, under the eaves, or in any sheltered inaccessible recess about the walls of a house; and at other times it selects the loftiest and most exposed branches of a tree. In the latter case it covers its nest with a rude dome of straw, and this instinctive desire for protection for its young from the elements may in some degree account for the choice of a site for the nest where it is artificially supplied. The following interesting description of the nest-building of these familiar birds may suffice to show the young naturalist how little need we have to travel for evidences of ingenious skill, or for subjects of study. In the vicinity of London three pairs of sparrows are believed to build their nests on trees for one pair that nestles in holes, though, when fairly within the crowded town, necessity will exercise a greater influence on the choice of the place for incubation:—"The circumstance which renders these nests most interesting, is their very different conformation, when built in a tree or under the shelter of a roof-tile. When a hole is selected it is first bedded with coarse straw, hay, and sometimes moss or similar materials, over which is laid feathers, wool, cotton, pieces of riband, tangled thread, or whatever the birds can find to suit their purpose. There is opposite our window, a faggot of sticks bound with a piece of old rope, which the sparrows have been employed half the summer in making into oakum, as a seaman would say; every fibre of loose ends having been carded out by their beaks, and carried off piecemeal. Last summer, a pair of these birds, unfortunately for themselves, carried off from the garden a long piece of bass; but when this had been successfully stowed

in the nest under the tiles, it appeared that they had not sufficient skill to work it into the fabric, and in their endeavours to manage it, both the birds entangled their feet so inextricably in the folds, that they were held close prisoners, one only having line enough to flutter about a foot beyond the entrance. How long they had remained thus entangled we know not, as our attention was called to their situation by the more than ordinary cackling of their neighbour sparrows, who had assembled, it appeared, more to scold the unfortunate pair for their carelessness, than to assist them in getting rid of the bass, for not one attempted to aid them. We therefore had them taken down, but they were so exhausted with their struggles that they did not long survive; and a pair of their scolding neighbours took possession of their premises a few days afterwards." *

The choice of the chimney swallow of a place for its nest is still more remarkable. It seems invariably to select an unused chimney shaft immediately adjoining to one where there is a constant fire, so as to avail itself of the warmth. They build somewhat low in the chimney, in order, as White of Selborn supposes, to secure their young from owls and other rapacious birds; but they have also been known to build in the shafts of coal-pits, and in old wells, so that they appear to have a natural predilection for such a place, and have had this instinct modified by the facilities furnished by the domestic architecture of our cold climate. The subject, however, is one which would furnish abundant reward for the study, could we afford the space here for following out the numerous examples wherein the special instincts of animals are thus seen to be modified by experience, and the manifest exercise of what we cannot otherwise characterize than as a reasoning faculty allied to that of man.

* Architecture of Birds, p. 319.

CHAPTER XIII.

EGGS OF BIRDS.

One remarkable characteristic of birds is their invariable production from the egg. A sufficient diversity in the colour of birds' eggs exists to admit of their being recognised for the most part, and classified, according to their natural order, from external appearance. In shape, however, they are all very nearly alike; insomuch that "egg-shaped," and the "egg-oval," are universally recognised as definite and well-understood terms. The great diversity in the eggs of insects, to which we have already alluded, is not the result of any apparent caprice, or needless variation of nature, but is at once accounted for from the remarkable dissimilarity of insect forms, the difference between the stag-beetle, the dragon-fly, the bee, and the ant, being greater than that which exists between any two classes of birds. Even the ostrich and the house-sparrow, or little humming bird, are nearly identical in general forms, so that a difference in size alone is required to adapt the bird's egg to the species. Nature is not, indeed, guided according to our ideas of mere utility. Besides the form, the colour is added, varying apparently for no other purpose than that which gives such endless beauty to the wild flowers and the insects' wings; but with all this, the manifest adjustment of means to an end are abundantly apparent, and hence a uniformity of structure is seen to prevail throughout the whole variety of birds' eggs.

No department of nature is better adapted for the purpose we have in view, in showing the evidences of wonderful contrivance, design, and the adaptation of means to an end, than that of the egg as seen in its various

stages— from the state when first laid, to that of perfect incubation.

The reader may be assumed to be familiar with the appearance presented by the egg when opened in its first stage. It consists then of the two substances, the yellow yolk, surrounded by the transparent and nearly colourless albumen in which it floats. On more minutely examining the yolk, there is seen on its surface a transparent molecule, with three points, which constitute the embryo of the future bird, precisely as the little point, already described, in the seed, contains the germ of the future plant, while all the rest included within the shell is destined for its nourishment until it assumes perfect form. The entire process of vital change from this embryo state to the full development of the bird, when the shell is broken, and it comes forth a living chicken, has been frequently observed and described, and nothing could be selected more fitted to exemplify the wonderful nature of the vital principle on which our being depends. To the naked eye the egg-shell, when opened, appears to be filled only with the viscid liquid, floating within the transparent albumen; but if exposed to the warmth created simply by the natural heat of the parent bird, the little speck begins to develop the rudimentary forms of the parent. By an ingenious and beautiful provision, the yolk is so suspended in the albumen, that, however turned, the vital spark, or embryo of the future bird, is always kept uppermost, so as to receive the greatest heat from the bird's body. When this mild but vivifying warmth has been allowed to operate for a short time, a small dark line is discernible on the outer pellicle, from which, after a little further exposure to the same heat, a ridge is seen to rise on each side, until the two at length unite, forming a canal, within which a semi-fluid matter is secreted. This gradually becomes darker and firmer, until two delicate parallel threads are apparent, which are the

rudiments of the spinal-cord. The vertebrae, or joints of the back-bone, next begin to form, appearing first as two minute rows of dots alongside of the canal first developed, but gradually extending round the rudimentary spinal-cord, so as to embrace it in a series of rings, which are ultimately attached together by muscles, and form the central trunk of the skeleton. The brain begins about the same time to appear at the head of the spinal-cord, in the shape of three little white specks, which speedily unite together, and the rudiments of the eye and ear appear. The gelatinous mass which surrounds this foundation of the perfect animal structure, now begins to be clouded with little opaque globules, and at length the whole is permeated by a system of vessels, through which nutrition is drawn towards the centre of development. At the centre of these vessels a little sac next appears, and this soon assumes its permanent form and its chief vital functions as the heart and centre of the system of blood-vessels. In this also positive vitality becomes first apparent. At the end of the second day from the commencement of incubation the quick and regular pulsations of the heart begin, which are thenceforth to continue while the life, thus mysteriously developed, endures. The digestive organs next appear, and the fluid of the yolk is now conducted into the stomach, and there prepared for nourishment, and passed through the blood-vessels, so as to contribute to the growth and development of the embryo bird. On the sixth day voluntary motion is detected, the lungs, which are not called into action till the young bird is hatched, become visible, and then succeeds the full formation of the breast-bone and ribs, the bill, &c.; and even the feathers begin to shoot. The chick is at length perfected in the shell, and at the end of three hundred and fifty-five hours, or towards the close of the fifteenth day from the commencement of incubation, the little germ, or scarcely visible speck, has

been developed into a perfect living bird, and its first cry is heard while still within the shell. Paley has remarked on the development of the lungs and of the eye, while yet the little bird is enclosed within the shell, as affording beautiful examples of prospective contrivance, and intelligent design. Speaking of the lungs, he remarks:—"Composed of air vessels where there is no air, elaborately constructed for the alternate admission and expulsion of an elastic fluid where no such fluid exists, this great organ, with the whole apparatus belonging to it, lies collapsed in the fœtal thorax, yet in order, and in readiness for action the first moment the occasion requires its service. This is having a machine locked up in store for future use, which incontestibly proves that the case was expected to occur in which this use might be experienced; but expectation is the proper act of intelligence. Considering the state in which an animal exists before its birth, I should look for nothing less in its body than a system of lungs. It is like finding a pair of bellows in the bottom of the sea, of no sort of use in the situation in which they are found; formed for an action which was impossible to be exerted; holding no relation or fitness to the element which surrounds them, but both to another element in another place." Yet, after all, how vain is it to select one feature more than another in this remarkable process as indicative of intelligent design and of divine wisdom. The argument of Paley, indeed, almost presupposes a latent idea of the chicken being its own creator, and reasoning out its development according to its ascertained functions, and the elements amid which its vitality has been evolved. We discern, indeed, a great truth in the fact that the lungs could only have been adapted to their functions by a Divine Chemist, cognisant of the properties of air, and of their action on the blood, and that the eye could not have been made without a like divine knowledge of optics. But even

now that the philosopher knows all the properties of the lungs, and all the optical skill expended on the eye, he can no more fashion either, than he can make an egg, and put into it a germ which heat shall develop into life, and make a perfect bird. In truth, if we are to deal with the infidel by such weapons, instead of seeking out the most complex and mysterious evidences of design, we may best, perhaps, reverse Paley's favourite argument. "When a bird's egg," says Lord Brougham, "is examined, it is found to consist of three parts; the chick, the yolk in which the chick is placed, and the white in which the yolk swims. The yolk is lighter than the white; and it is attached to it at two points, joined by a line, or rather plane, *below* the centre of gravity of the yolk. From this arrangement it must follow that the chick is always uppermost, roll the egg how you will; consequently, the chick is always kept nearest to the breast or belly of the mother while she is sitting. Suppose, then, that any one acquainted with the laws of motion had to contrive things so as to secure this position for the little speck or sac in question, in order to its receiving the necessary heat from the hen—could he proceed otherwise than by placing it in the lighter liquid, and suspending that liquid in the heavier, so that its centre of gravity should be above the line or plane of suspension? Assuredly not; for in no other way could his purpose be accomplished. This position is attained by a strict induction; it is supported by the same kind of evidence on which all physical truths rest. But it leads by a single step to another truth in Natural Theology; that the egg must have been formed by some hand skilful in mechanism, and acting under the knowledge of dynamics."* On like reasoning it is that all Natural Theology is based. If we pass over a common, says Paley, and strike the foot against a stone, we do not stop to ask who

* A Discourse of Natural Theology, p. 33.

placed it there; but if we find a watch instead, we at once ascribe its origin to design and mechanical skill, and conclude that some one must have been there before us, who dropt it on the ground. Yet let the infidel lift the stone, perchance a bit of granite, one of the most abundant of all rocks; it is *only a stone*, and requires no reason to explain its chance presence there: yet, on examining it more closely, and breaking it to expose the true colours and consistency, it is seen to be one of the most beautiful rocks, and viewed mineralogically, its composition is no less remarkable. Its constituents are mica, felspar, and quartz, each in distinct crystals, or filling up the smaller interstices, and each crystal having a definite and regular shape, and an angle of its own as uniform as that of the cell of the bee. Other minerals may also sometimes be found present, modifying the appearance of the granite, such as chlorite, talc, garnet, steatite, &c., each exhibiting new forms of crystallization, and thus disclosing proof, that in this chance-found and apparently shapeless stone, natural laws have been, and still are, in action, no less remarkable than any which the phenomena of vitality and reproduction exhibit in the animal kingdom. It demonstrates the fact that intense heat has largely operated in producing the earlier changes through which the globe has passed; it exhibits the law of gravitation in operation, and yet influenced by other and no less uniform and mysterious laws of matter over which it is evident that mere chance exercises as little influence. as over the development of the chick in the egg during the wondrous process of incubation.

It is a great truth which the book of nature most clearly reveals to us, that chance has nothing to do either with the processes of the world, or the affairs of of man. Nothing is too minute or insignificant to be undeserving of the Divine and overruling care. A curious provision in the chick is worthy of notice here. While

still shut up in its shell, the bill remains soft and fleshy, only gradually assuming its full development. Even if perfect, it would be very poorly adapted for the first voluntary action which instinct teaches the imprisoned bird to make, in order to break through the walls of its cell. It is, accordingly, provided with a small, sharp, and hard protuberance, called the *bill-case*, with which, as with an axe, it chips the shell, and escapes into the outer world. This done, the bill-case has served its purpose, and it soon after becomes detached, and drops off. The remarkable progress which may be thus followed from stage to stage in the egg, is an example of the early processes through which all animal organization has to pass, in some form or other. In some reptiles the eggs are hatched without being laid; in the higher ranks of animal life this process is carried on in the womb, and the embryo is fully developed before it is brought forth. In insects, again, the egg gives forth only an imperfect and inferior form, which has to pass through various stages before it attains to completeness and maturity.

CHAPTER XIV.

REARING THE YOUNG.

A MARKED difference in the number of the eggs laid by different species of birds forms one of the many remarkable provisions by which animal reproduction is protected and controlled by fixed laws. The pigeon lays only two eggs at a time, but it rears several broods in the season. Most birds, however, only rear one brood in the year, and as a general law it is found that birds of prey produce their young much more sparingly than others of the feathered tribe. The eagle and the vulture lay only two

eggs, and rear but one brood in the season; the hawk, the owl, and other rapacious birds, in like manner increase slowly, and are found in their most favourite localities only in very small numbers, compared with those on which they are accustomed to prey; while the feeble little wren lays frequently as many as sixteen eggs, and rears the whole brood. Yet a curious instinct seems to control this important law of reproduction. We are familiar in the case of the domestic hen, with the fact that, in the spring, when she begins to lay, if left undisturbed, she will provide a nest, and having there deposited a certain number of eggs, she then ceases to add to their number, and proceeds to the maternal work of incubation. If, however, the eggs are removed, the hen continues to lay others to an almost unlimited extent. Nearly the same is the case with birds in their natural state. If their eggs are left untouched, they lay only the fixed number, but if these are destroyed or removed, they will repeatedly replace them. The yellow hammer, for example, has been known to lay seventeen eggs, when they have been removed, one at a time, from the nest, without abstracting the whole. The bird at length became wearied of its fruitless labour, and deserted the nest, probably choosing another spot for resuming its maternal duties. When the chickens are hatched, a total change of duties devolves on the parent birds. The voracity of the young is extreme, their appetites being adapted to their rapid growth and development. A young sparrow will eat its own weight of food in a single day; we may therefore conceive of the unwearied care and toil which devolves on the parents after the brood is hatched, to provide for a nestful of such clamant and greedy offspring. The instinctive care of the parent bird, however, is shown in the selection of the proper food, and in some in its preparation, as well as in the regulation of the requisite supply. The pigeon, for example, is specially remarkable

for one provision of its internal organization. The crop in its ordinary state is a thin membrane, with the internal surface smooth; but a total change occurs on it preparatory to the hatching of the young brood. The crop then increases to a thick and glandular bag, having the internal surface rough and irregular; and within this all the food of the young pigeon undergoes a preparatory process of a very peculiar kind. A milky fluid of a grayish colour is secreted by the glands and poured in upon the grain and seeds, which have been collected in the crop to undergo the needful preparation for suiting them to the delicate digestive organs of the young pigeon. The whole apparatus bears a considerable resemblance to the provision by which quadrupeds are nursed in the earliest stage of existence, on their mother's milk.

The fluid secreted in the female lacteal glands, by means of which the offspring of quadrupeds are supplied with food admirably adapted for their nourishment in the earliest stage of their existence, is one of the most important differences between birds and beasts, in the propagation of their species, accompanying as it does the production of the one from eggs, while in the other, the same process is carried on in the womb, and the young are brought forth alive and fully formed. The same laws, however, which regulate the balance of numbers between rapacious birds and those on which they prey, control the reproductive powers of quadrupeds. The lion and tiger bear only once a-year, and rarely bring forth more than two or three young ones at a time. They are also, like all the great cat family, entirely unsocial, so that their ravages are in no case multiplied either by the union or the sagacity displayed in the combined operations of the dog or wolf. Each, with his female partner, occupies a solitary den, usually concealed in some obscure retreat in the wide jungle or forest. Were it otherwise, it would seem nearly impossible for any other creatures to live in a region oc-

cupied by them, so that they must speedily effect their own destruction by the annihilation of their whole means of subsistence. The bound with which the tiger springs from his ambush, and dashes himself on his prey, is astonishing and terrible, and may be said to be irresistible in its effects. Man appears as a mere puppet in the clutch of this ferocious animal, which has been known, as in the case of Sir Hector Monro's unfortunate son, to dash into the midst of a party of armed men, and paralyzing the whole by its sudden and tremendous roar, to carry off with ease its victim, apparently, indeed, scarcely feeling any impediment from the weight of a full grown man. Even the great Indian buffalo is borne down by this ferocious beast, and dragged off through the jungle without any violent exertion of its enormous strength. To such voracious animals, a large district is needed for the range of a single pair, where the flocks of the herbiverous animals abound, and where the immense preponderance in the number of the latter shall prevent the violent inroads of their dread foe from becoming so frequent as to scare them from the district.

The maternal feelings both of the lioness and tigress are very strong, and while attending on their cubs they will brave every danger, and seem scarcely susceptible of fear, either in their defence or in hunting for their prey. Captain Williamson relates, that when he was in an Indian district, two tiger cubs were given to him, which had been brought from a considerable distance by some natives who obtained possession of them during the absence of the tigress. The Captain secured them in a stable, where they made a considerable noise, notwithstanding their being supplied with abundance of food. After having been thus secured for several days, the bereaved tigress arrived during the night, attracted apparently by their cries, to which she replied with the most fearful howlings; and such was the violence of her fury, that the

cubs had at length to be let loose, under the apprehension that the tigress would break in and glut her wrath on the robbers of her young. In the morning, it was found that she had carried both the cubs back into the jungle. The parental instincts are peculiarly conspicuous in the largest carniverous quadrupeds. Among birds in general, the male performs a part in the rearing of the young not greatly inferior to that of the female. It largely aids in building the nest, frequently shares the duties of the hen bird during incubation, and performs its part in feeding and defending the young, with a zeal little inferior to that of the mother. Among quadrupeds, in general, no such paternal care is needed. The milk of the mother supplies all that is needful for the sustenance of the young, and accordingly, in the great majority of cases, and especially among gregarious animals, all parental affection is confined to the female, the males being apparently totally unconscious of any feeling of interest in the wellfare of their offspring. It is otherwise, however, with beasts of prey, and for obvious reasons. With herbiverous animals, the food of the mother, and of the young animal, so soon as it is able to graze, is at hand, and no exertions of the male could contribute any additional facilities to its rearing. The habits also of gregarious animals sufficiently provide for the safety of the herd without the special attention of the males to any particular female. But beasts of prey almost invariably live in solitude, their food has to be sought uncertainly and at a distance. Frequently it requires long watching to secure their prey, and when discovered, it is not obtained without both danger and toil. The male, accordingly, among carniverous animals, is generally found constant to one female, and continues with her until their offspring are reared. Even in captivity, the lioness becomes very fierce and savage, so soon as she has cubs, and in a state of nature both parents guard their young with the greatest jealousy.

In ordinary cases, unless when pressed by hunger, the lion does not readily attack man, when unassailed by him; but when watching their young, all such fear ceases, and the suddenness of their attack is terrible. Mr. Bennet relates that in the commencement of the year 1823, General Watson, while on service in Bengal, was out one morning on horseback, armed with a double-barrelled rifle, in search of sport. While riding along, he was suddenly surprised by a large lion, which bounded out upon him from the thick jungle, at the distance of a few yards. Fortunately, he retained his presence of mind, and firing with a steady aim, the shot took complete effect, and the monster fell dead at his feet. But no sooner had the lion fallen, than the lioness sprang out from the same jungle, and bounded towards the assailants. A second shot from the General's well-directed rifle, wounded her severely, and she retreated into the thicket. It was concluded from the appearance of both together, that the den could not be far distant, and the party accordingly followed on the track of the lioness, and traced her to her retreat, where she was speedily despatched. Here they found two beautiful little cubs, a male and a female, apparently only a few days old, which they brought away with them. They were suckled by a goat, and afterwards sent by the General to England, as a present to George IV., by whose command they were lodged in the Tower. When the young begin to share in the spoils of the chase, the lioness becomes devoid of all fear: she attacks indiscriminately whoever comes within her reach, and fights with peculiar fury in their defence. Many stories have been told about the generosity and fidelity of the lion; but though he appears to exhibit the parental instincts with considerable force, the nobility of disposition otherwise ascribed to him, has no just foundation, and the tiger only surpasses him in fierceness from superior courage, and also frequently from

greater strength. The strength, however, of the lion, is not greatly inferior to that even of the great Bengal tiger, and but for the immense advantage which the rifle supplies, it would scarcely be possible to venture on a direct attack. To carry off a man, is a feat which he accomplishes apparently with the utmost ease; and a Cape lion has been known to seize a heifer in his mouth, and though the legs dragged on the ground, it seemed to carry off its prey with as much ease as a cat does a rat, leaping over a broad dyke with it, without the least difficulty. In one case, where a lion was pursued when thus loaded with a heifer, the mounted hunters continued the chase for five hours, and during the whole period the carcass appeared only twice to have been laid down.

The great fecundity of the rabbit, the sow, and other animals, which form the prey of the carnivora, and the immense herds of the buffalo, wild horse, antelope, and other herbiverous animals, which furnish the like supplies to the largest of the savage tribe above described, show how strikingly the defencelessness of their nature is compensated for by other means, and thus what may be termed the balance of creation, is uniformly preserved. The peccaries, for example, which abound in the extensive forests of South America, and subsist on roots and other vegetable food, which they obtain by burrowing in the ground, congregate in numerous bands. The white-tipped peccaries, especially, are said to roam about in herds exceeding a thousand in number; and should an unfortunate huntsman venture to attack them when thus congregated, he is sure to be surrounded by the whole herd, and torn to pieces with their tusks, unless he succeeds in getting up a tree out of their reach. Hunters have sometimes been kept prisoners for many hours, surrounded in this manner by the infuriated herd, the members of which seem to acquire courage from their numbers,

as small bands of peccaries exhibit no such daring or pertinacity, but are readily put to flight by very slight resistance.

The American bison, in like manner, occupies the vast uninhabited parts of North America, extending from Hudson's Bay to Louisiana and the frontiers of Mexico, and forms an abundant source of supply both to the wild hunter and to the beasts of prey. Modern travellers concur in bearing testimony to the almost incredible numbers of the herds of the bison which assemble on the banks of the Missouri. Captain Lewis remarks: "Such was the multitude of these animals, that although the river, including an island over which they passed, was a mile in length, the herd stretched, as thick as they could swim, completely from one side to the other;" and he estimates the moving multitude on another occasion, as not less than twenty thousand. Dr. James, another intelligent observer, tells us that, "in the middle of the day, countless thousands of them were seen coming in from every quarter to the stagnant pools." The spring-bok, the nyl-ghau, the Indian antelope, and numerous other herbiverous animals, including the elephants of the Asiatic and African continents, are found always in numerous herds, and roam in social freedom over the vast unoccupied regions of the old world.

Such is the remarkable contrast everywhere seen between the most powerful carniverous and herbiverous animals. In the present economy of nature, these carniverous animals seem as indispensable to restrain within the needful limits the vegetable feeding herds, as are the various destroyers of the superabundant insect caterpillars and grubs, which would otherwise desolate the vegetable kingdom as with a noxious blight. We have already acknowledged that such laws must be regarded by us as mysteries, the precise reconcilement of which with the perfect benevolence of Him who is wisdom and holiness,

justice, goodness, and truth, we cannot fully realize. These are not the pages in the Book of Nature which we would select as the most eloquent evidences of design, and harmonious adjustment, though we doubt not that they also are reconcileable with the perfection of the divine attributes. But we cannot omit seeing and acknowledging the principle that guided that adjustment to which we here refer, and which prevails alike in the sea as on land. There the whale, the porpoise, the walrus, the seal, the cod, and the herring, are all found congregated in large shoals, while the ferocious shark, the tiger of the sea, swims in solitude through its vast depths, like the lonely tiger or the lion amid the Indian jungles or the African plains.

Were it otherwise, and could we conceive of lions and tigers roaming in herds, or of the great elephant endowed with the lion's hunger, and the tiger's ferocity, it would seem that the world must be depopulated in a single generation; and did the whales and porpoises that gambol about the deep in shoals, pursue their prey with the hideous rapacity of the shark, they, too, must soon be left to prey on one another, until the ocean also was desolated, and earth and sea ceased alike to know a living thing. But it is altogether different. It is to us a mystery, which in this life will never be fully solved, that pain, and suffering, and death, appear to be established by inevitable law; but that great mystery, *the origin of evil,* being left unsolved, we still can discern the provisions of creative wisdom, by which the scheme of animated creation remains a harmonious and well adjusted system, wonderfully manifesting to us on every hand, the overruling providence of the great and good God, whose eyes are over all his works, and whose words unto us are: Who is this that darkeneth counsel by words without knowledge? Knowest thou the ordinances of Heaven? Canst thou set the dominion thereof in the earth? Who

hath put wisdom in the inward parts? or who hath given understanding to the heart? Who can number the clouds in wisdom? or who can stay the bottles of heaven, when the dust groweth into hardness, and the clods cleave fast together? Wilt thou hunt the prey for the lion, or fill the appetite of the young lions, when they crouch in their dens, and abide in the covert to lie in wait? Who provideth for the raven his food? when his young ones cry unto God, they wander for lack of meat. Knowest thou the time when the wild goats of the rock bring forth? or canst thou mark when the hinds do calve? Canst thou number the months that they fulfil? or knowest thou the time when they bring forth? They bow themselves, they bring forth their young ones, they cast out their sorrows. Their young ones are in good liking, they grow up with corn; they go forth, and return not unto them. Who hath sent out the wild ass free? or who hath loosed the bands of the wild ass? whose house I have made the wilderness, and the barren land his dwellings. He scorneth the multitude of the city, neither regardeth he the crying of the driver. The range of the mountains is his pasture, and he searcheth after every green thing. Will the rhinoceros be willing to serve thee, or abide by thy crib? Canst thou bind the rhinoceros with his band in the furrow? or will he harrow the valleys after thee? Wilt thou trust him, because his strength is great? or wilt thou leave thy labour to him? Wilt thou believe him, that he will bring home thy seed, and gather it into thy barn? Gavest thou the goodly wings unto the peacocks? or wings and feathers unto the ostrich? which leaveth her eggs in the earth, and warmeth them in the dust, and forgetteth that the foot may crush them, or that the wild beast may break them. She is hardened against her young ones, as though they were not her's: her labour is in vain without fear; because God hath deprived her of wisdom, neither hath he imparted to her understanding. What

time she lifteth up herself on high, she scorneth the horse and his rider. Hast thou given the horse strength? hast thou clothed his neck with thunder? Canst thou make him afraid as a grasshopper? the glory of his nostrils is terrible. He paweth in the valley, and rejoiceth in his strength: he goeth on to meet the armed men. Doth the hawk fly by thy wisdom, and stretch her wings toward the south? Doth the eagle mount up at thy command, and make her nest on high? She dwelleth and abideth on the rock, upon the crag of the rock, and the strong place. From thence she seeketh the prey, and her eyes behold afar off. Her young ones also suck up blood: and where the slain are, there is she.

In the sublime language of the Book of Job, the presumptuous challenger of the wisdom and consistency of the entire scheme of Providence in reference to the works of creation, finds an abundant answer: "Shall he that contendeth with the Almighty instruct him? He that reproveth God let him answer it." Amid all the lessons, indeed, which the Book of Nature discloses for our instruction, there is no one so manifestly enforced on its every page, as that of our own individual insignificance, and entire dependence, at every moment, on the sustaining providence of our Creator. In Him we literally live, and move, and have our being; and he who, looking on creation, can behold on the one hand the immensity of the stellar universe, and on the other the minuteness of microscopic life, and yet fail to learn the lesson of humble and devout reliance on the divine rule, must be incapable of comprehending the simplest of the revelations of creative wisdom, power, and goodness.

CHAPTER XV.

CHARACTERISTICS OF THE SEASON.

Reasoning, as we necessarily do, from the Book of Nature, we assume the existence of a divine Creator, whose character may be discerned by us from an investigation of his works. If we learn of any man the entire course of his proceedings, the nature of his plans, the character of his dealings with others, and the general purposes of his life, we can be at no loss in coming to a distinct conclusion concerning him; and though we cannot hope to be able, in like manner, to comprehend the divine character, yet, by such a course of reasoning, pursued in a humble and devout spirit, we may hope to discover some new and important phases of Natural Theology, confirming our faith in the more perfect revelations of the written word. Throughout the whole vegetable and animal kingdoms we trace distinctly a harmonious scheme, designed with consummate wisdom for the attainment of certain general ends, which we hence assume to have been purposely aimed at by these means, precisely as we are able to assign the purpose of many of the minor provisions of nature already described; while others which have escaped our notice, or even been presumptuously supposed to be blemishes and shortcomings in nature, are found to have been provided for like wise ends. An interesting illustration of this is furnished by a writer in the "Gardener's Chronicle," with reference to one of the most familiar of spring's harbingers. On which he remarks:—"The crocus appears to me to furnish an instance of adaptation to a peculiar natural locality, which, as far as I am aware, has not hitherto been noticed in print. Gardeners know that their patches of crocuses rise to the surface in a very few years, so that you cannot rake the

beds in which they grow without dragging them from their places. In old, neglected gardens, about farm-houses or untenanted mansions, the corms, or, in popular language, the bulbs, will probably be quite exposed, without a sprinkling of mould over them. Now, this exposure is not necessary for the health of the plant, but the contrary. It will thrive better at the depth of at least three inches. There must, therefore, be some other final cause, if any, for this gradual uprising, by the annual formation of a new corm above that of the previous spring.

"Having occasion, some years ago, to pass through Switzerland by the route of the Simplon, I observed, a little below the village that bears that name, and of course on the Italian side of the descent, a large tract covered with crocuses. It was in the middle of May, but they were not yet in bloom. Although to this day quite ignorant of their size, colour, or species, I have often regretted that I did not dig some up to bring home with me. It would have been so easy; only a little pleasurable trouble. But regrets are unavailing, except as warnings to avoid, so far as depends upon ourselves, all future causes for regrets.

"Spring creeps very slowly up the sides of the mountains even with a southern aspect. They had not long been uncovered from the snow, which, a little higher up, was thawing from day to day. The spot occupied by the crocuses was a swampy hollow of considerable extent, but I observed none on the drier hillocks around it. The swampiness was caused, not by one of those little burns so innumerable and so beautiful in mountainous countries, but by the trickling down of the water from the line of melting snow, which brought with it, from the hill-side, a small but perceptible deposit of mud. This thin layer is of course annually repeated, and a stationary bulb would in a few years be buried beyond the power of vegetation. I cannot think it fanciful to believe that the

upward progress of the corms is designed to enable them to keep pace with the gradual elevation of the soil in which they are rooted.

"The narcissus, which grows wild in the south of Europe, in marshes that are from time to time inundated, also rises, though more slowly than the crocus. The garden hyacinth likewise moves upwards. The tulip and the meadow saffron (*colchicum autumnale*) appear to have the faculty of accommodating themselves at once to the most suitable depth of soil, forming an entirely new bulb above or below the old one, which is left a hollow shell; as if its whole substance had been transferred, like the honey that bees will remove from the comb in a bell glass to the hive beneath. A curious essay might be written on the locomotion of plants, by any one who chose to avail himself of the information which our great horticultural and botanical institutions render available to the industrious. Were it not for the power of rising to the surface, my unknown crocus of the Simplon would in a few years certainly be overwhelmed by the annual top-dressing; and the species affecting such situations would become extinct, for some species of the crocus rarely seed. As it is, those in the Alps may have risen yards. Some of our native orchids, by the yearly decay of one of their two bulbs, and the formation of a fresh one on the opposite side, proceed onwards at not a slow rate. The strawberry puts on seven-leagued boots in comparison, and frequently escapes from the rich man's garden to refresh the way-side traveller. How many years would it take a new seedling strawberry to travel by runners from London to the Land's End? The raspberry mines its way to a fresh station, by a subterranean, mole-like process, blind but not unguided, and then rises unexpectedly to the light of day. The elaterium, or squirting cucumber, is furnished with a fire-engine for the dispersion of its seeds; the touch-me-not balsam scatters

them like an exploded shell. Even the humblest of the race, the champignon, and many other fungi, start from a centre and travel outwards in circles, imitating, in their lowly way, the progress of sound and light.

"If it be asked—Why should the Supreme Being bestow this care on the preservation of a useless, unseen crocus, that vegetates amidst perhaps inaccessible hill-tops, where there is scarcely an insect to sip its sweets, much less a human eye to admire its beauty?—we in return demand—Is it for your own merits, caviller, for your usefulness, your services to mankind, that you have been created, supported, and spared so long by the mercy of a benevolent God?"

If we were to insist on applying our own standard of an economic utility to all the works of creation, we should indeed speedily find ourselves at a loss to comprehend the purposes of the universe; yet we cannot doubt but that each object subserves the purpose of its creation to an extent of which we have but a slight perception. The very harmony of nature accomplishes ends the value of which we can in some degree appreciate. Sir James Smith observes: "We can but imperfectly account for the green so universal in the herbage of plants; but we may gratefully acknowledge the beneficence of the Creator, in clothing the earth with a colour the most pleasing and the least fatiguing to our eyes. We may be dazzled with the brilliancy of a flower-garden, but we repose at leisure on the verdure of a grove or meadow." In this, however, we must also remember, that He who made the green meadow and grove made also the eye, and this is only another of the innumerable instances of the harmony which prevails everywhere throughout the Creator's works.

Let us now, however, examine the different ends which are apparent to us in the study of nature. Those of reproduction, the continuation of the species, and the

adjustment of their numbers, localities, and habits, so as to preserve the original balance, and prevent the destruction of one portion by the excess of others, are all sufficiently apparent. But we can readily see that these might have been attained by other means had nothing more been aimed at. These show the power of the Creator, but in them also the devout student discovers still larger evidence of his unbounded goodness, and his fatherly care over all the works of his hand. Recognising, as we do, the distinct purposes of continuous existence in the works of creation, we are compelled to own that the means by which this is secured, display consummate wisdom. The appetites and passions, the tastes and desires, the functions and propensities of animated nature, all prove the purpose of the reproduction, and of the continuation of the various species of living beings, by their Creator, and of his possession of a degree of power and wisdom such as we are incapable of conceiving of otherwise than by its manifestation in ourselves, and in the countless living evidences of such creative power. But we who are dependent on the Divine bounty for life, health, and all that renders existence desirable, are deeply interested in searching for the evidences of other attributes besides those of wisdom and power. When we turn back to examine the ideas of the Supreme Being, which have been entertained by those nations most celebrated in ancient times for their science and profound learning, we find that neither philosophy nor religion was able to supply them with that well-grounded hope and assured confidence which can alone rob death of its terrors. The old Egyptian recognised indeed a doctrine of probation and of retribution. He believed in some degree that the Supreme Being loved virtue and hated vice, and that he had made the happiness both of this world and of the next depend on the fulfilment of those duties which the law of conscience, in every man's breast, teaches him to

practise. Yet, along with this same belief, he entertained the strangest fatalists' creeds that the perverse ingenuity of the human mind has ever invented. In addition to the doctrine of transmigration, which taught that the souls of those who had sinned during this life were returned to the earth to inhabit the bodies of swine, and other unclean animals, the Egyptian also believed in the cycle or "great year," a fixed period of time, at the end of which all things would return to their former state, and each human being live over again all the joys, and all the sorrows of his former life. A more hopeless creed it would be difficult to conceive of. Yet in some respects it is of a higher character than anything we find in the more refined mythology of Greece and Rome. There the deity is most frequently presented to us under an aspect revolting to our sense of virtue and rectitude, in so much so, that the religion of the most civilized nations of the ancient world seemed fitted rather as an encouragement to vice than an incentive to virtue. The example of the gods might be quoted by the most licentious and depraved, while to the virtuous, the Supreme Being must have oftener appeared an object of apprehension and dislike, than an author of happiness, and a rewarder of virtue. The light of reason and the Book of Nature were the only guides which these old heathen nations possessed to a knowledge of the Divine attributes. We may, therefore, properly inquire how far the conclusions they arrived at were borne out by such evidence. Doubtless we owe that to the clearer light of revelation which no unaided reason could have taught us, yet we are also justified in affirming that these heathens made a most imperfect use of the knowledge they had, walking "as other Gentiles, in the vanity of their mind, having the understanding darkened, being alienated from the life of God through the ignorance that is in them, because of the blindness of their hearts." We think that it may be as clearly affirmed from the evidence

already produced, that God is good, as that he is wise or powerful.

We perceive in all the natural stimulants of animal life, not only a means for securing the exertion requisite to the continuance of healthful existence, but also a constant source of enjoyment, and of pleasurable change. If we consider even the most common cravings of hunger and thirst by which our appetites are so regulated as to secure the regular needful supplies on which the sustenance and vigour of our bodies depend, we can readily understand how the Creator might have made a sense of pain, rather than of pleasure, furnish the stimulus of exertion; as may be sometimes seen in cases of disease, where the daily recurrence of pain has to be mitigated by drugs, opiates, blisters, and the like remedies, which are in themselves only tolerable because of the relief they give from greater evils. Hunger and thirst, in so far as they merely indicate the daily return of the periodical desire for food, are neither felt by us, nor by any of the lower animals, as in any degree painful, while the repast by which they are removed is pleasurable to all. But this is still more manifest in all those affections and instincts which are connected with the continuation of the species. In the season of spring the whole woods are vocal with the melody of birds, and the reviving hum of insects; and nature seems to awaken to universal cheerfulness solely because of the joy attendant on the loves and parental duties of the season. The entire process of nest-building, which would otherwise be a source of labour, restraint, and pain, is rendered the pleasurable exercise of instincts, which not only secures the propagation of the future progeny, but furnishes the highest sources of enjoyment to the living race. So completely does the evidence of pleasurable occupation pervade the whole labours of the spring, that even the most inharmonious sounds seem to become agreeable to the ear. At no period of the year is the

rook more noisy, yet its endless cawing sounds pleasantly among the smoky trees, where it often builds, almost within reach of the windows, in large towns. Early in March the flock of rooks are found busy wheeling about their nests, repairing the old ones, or gathering sticks for new structures. The young pairs, beginning their labours for the first time, are busy filching from their neighbours' nests, and being visited in return by the merciless administrators of rook-law and justice, according to the amusing accounts of Goldsmith and other naturalists. Their ideas of a permanent and hereditary right to the possession of the localities occupied by their nests appear to be peculiarly tenacious. Dr. Heysam gives a curious account of a dispute for the possession of a grove, between the natives of a rookery and a party of invading herons, at Dallam Tower, in Westmoreland. Some fine old oak trees, occupied by the herons, had been felled, and the consequence was, an attempt to encroach upon the tenure of the rooks. This the latter resisted with no little noise and vigorous opposition; and for two successive seasons a series of regular fights and skirmishes was carried on, though the invading herons had, on the whole, the best of the fray. At length a sort of peace seemed to be patched up between the combatants, and the rooks and herons apparently agreeing to a division of the only remaining grove, the two parties continued thereafter to build their contiguous nests without further altercation.

The business of incubation is no less obviously a source of pleasurable duty than the nidification. The male then delights to sit on a neighbouring bough, and cheer his mate with his blithest song. He takes also his share in the parental labour, and some curious instances have been recorded where the male bird has attempted to complete the work of incubation when the female, by some mischance, has been killed. In 1822, Dr. Neill of Edinburgh, obtained a male bird of the common heron, which

he placed in the garden of his house at Canonmills, where it soon became so tame that it would follow him for food. After some years a young female heron was presented to him, and the two having associated together, several eggs were laid by the hen in the spring of 1828. Unfortunately, however, the poor hen, having strayed to the banks of a neighbouring mill-pond in search of food, was shot by a thoughtless youth, who chanced to be out with a fowling-piece. The male heron, however, although it had been caught quite young, and had been kept for six years in its state of friendly captivity, without once seeing any of its own species, required no instruction to guide it to the fulfilment of the parental duties. It had shared with the female her earlier cares, and used to sit on the nest when she was absent for food. During the whole time of pairing, the male was very bold, bristling up his feathers and snapping his bill when any one approached the nest. On the death of his mate he undertook her duties, and continued perseveringly to sit on the nest for several entire days; but having no one to relieve him, he seemed at length to tire, and the nest was abandoned. Instances, somewhat similar to this, of the male bird seeking to supply the absence of the female, have been frequently recorded by naturalists. But what we would chiefly dwell upon here are the evidences of these parental instincts being invariably a source of enjoyment to all. At no other season do we discover indications of the same happiness as in the spring season of love, and at no other period are the notes of the birds so musical and replete with joy. The whole season, indeed, seems one of pleasure. The lark is carolling high in the air, and thrilling all ears with his gladsome notes. The swallows are twittering from their clay-built nests, as they labour to complete these ingenious fabrics, or dart out on their swift wings, and return again as if in the exuberance of their joy. The sweet young herbage, the soft green tints

of the new-burst leaf-buds on the trees, the early fruit-blossoms, and renewal of verdure everywhere, seem to speak of the season as one pre-eminently dedicated to the happiness of all living nature.

As the contemplation of the material universe thus exhibits the Divine Being to us as the author of a system manifestly designed for producing happiness to all living creatures, we thus recognise in these traces of the God of nature evidences of the same Supreme and Holy Governor of all things, who has been already proclaimed to us in the Book of Revelation as the Lord God, merciful and gracious, and abundant in goodness. The Rev. William Whewell has thus illustrated some portion of this subject in his Bridgewater Treatise:—"The Author of the bodily structure of animals must also be the Author of their instincts, for without these the structure would not answer its purpose. And these instincts frequently assume the character of affections in a most remarkable manner. The love of offspring, of home, of companions, is often displayed by animals in a way that strikes the most indifferent observer; and yet these affections will hardly be denied to be a part of the same scheme as the instincts by which the same animals seek food and the gratifications of sense. Who can doubt that the anxious and devoted affection of the mother-bird for her young after they are hatched, is a part of the same system of Providence as the instinct by which she is impelled to sit upon her eggs? and this, of the same by which her eggs are so organized that incubation leads to the birth of the young animal? Nor, again, can we imagine, that while the structure and affections of animals belong to one system of things, the affections of man, in many respects so similar to those of animals, and connected with the bodily frame in a manner so closely analogous, can belong to a different scheme. Who, that reads the touching instances of maternal affection, related so often of the women of all

nations, and of the females of all animals, can doubt that the principle of action is the same in the two cases, though enlightened in one of them by the rational faculty? And who can place in separate provinces the supporting and protecting love of the father and of the mother? or consider as entirely distinct from these, and belonging to another part of our nature, the other kinds of family affection? or disjoin man's love of his home, his clan, his tribe, his country, from the affection which he bears to his family? The love of offspring, home, friends, in man, is then part of the same system of contrivances of which bodily organization is another part. And thus the Author of our corporeal frame is also the Author of our capacity of kindness and resentment, of our love, and of our wish to be loved, of all the emotions which bind us to individuals, to our families, and to our kind." *

But while we thus search out, in nature, the evidences of benevolent design, let us not forget that nature—and still more man—is far short of perfection. "God made man upright, but he sought out many inventions." Modern sceptical philosophy, dissatisfied with the simplicity of the sacred narrative, has striven, with a grudging faith, to regard the Mosaic history of primeval times as a myth which rather embodies some symbolic conception of the creation and earliest proceedings of the race, than as a simple narrative of facts. But the humble believer in the revelation of Divine truth, enjoys a higher privilege than all the boasted wisdom of philosophy. He believes that God created man a rational, moral, accountable being; placed him in this probationary state of being, free to choose his course; but while surrounding him with all the tokens of paternal benevolence, which made of his home a paradise, he demanded of him one act of obedience and self-denial as the evidence of his subject love. Was not this consistent with the most ample display of

* Whewell's Bridgewater Treatise, p. 261.

paternal goodness by his Creator? Our conscience not only assures us that it was, but that some such test seems to have been indispensable to the probationary state of man, and the allegiance of the creature to the Creator. Man, however, fell. He chose disobedience, yielded to temptation, made his free choice of serving his own lusts rather than God's will; and the conscience of each man tells him that, in a thousand ways, he too has knowingly disobeyed the Divine will, and chosen evil rather than good.

The Christian cannot, while searching the Book of Nature, forget this higher truth, which furnishes the key to so much that seems otherwise incapable of being fully understood. God has indeed cursed the earth for man's sake; and this not less in love than in wrath; for wise men own the primeval curse,—"In the sweat of thy face shalt thou eat bread,"—to be a blessing rather than a curse to fallen man. Yet we will not conceal the difficulties of the question, which the human mind has intelligence enough to ask, but has no sufficient intelligence or knowledge to reply to; and which the wisest, in humble piety, are content to adjourn the solution of to that future state of being, when "we shall no more see through a glass darkly." Dr. Chalmers thus wisely and eloquently deals with these imperfections of every system of natural religion:—"Many there are who would gloss over the difficulties of the question, and who, in the midst of all that undoubted outrage which has been inflicted by sinful creatures on the truth, and the holiness, and the justice of God, would, by merging all the attributes of the Divinity into a placid and undistinguishing tenderness, still keep their resolute hold of heaven, as at least the splendid imagination, by which to irradiate the destinies of our species. It is thus that an airy unsupported romance has been held forth as the vehicle on which to embark all the hopes and the hazards of eternity. We would not

disguise the meagreness of such a system. We would not deliver the lesson of natural theology, without telling at the same time of its limits. We abjure the cruelty of that sentimentalism, which, to hush the alarms of guilty man, would rob the Deity of his perfections, and stamp a degrading mockery on his law. When expounding the arguments of natural theology, along with the doctrines which it dimly shadows forth, we must speak of the difficulties which itself suggests, but which it cannot dispose of; we must make mention of the obscurities into which it runs, but which it is unable to dissipate,—of its unresolved doubts,—of the mysteries through which it vainly tries to grope its uncertain way,—of its weary and fruitless efforts,—of its unutterable longings. And should, on the one hand, the speculations of human ingenuity, and, on the other, the certainties of a well-accredited Revelation, come forth to illuminate this scene of darkness, we must not so idolize the light, or the sufficiency of Nature, as to turn from the firmament's meridian blaze, that we might witness and admire the tiny lustre of the glow-worm."

We see, then, that the Book of Nature must be studied with the conviction that its revelations are limited and imperfect, and though always true so far as they go, are not seldom liable to miscomprehension and overstraining. Sad indeed is it to think that hundreds, if not thousands, in our own day, have converted those wondrous evidences of Divine wisdom, goodness, and boundless power,—some examples of which we have here selected in illustration of our subject,—into the basis of a doctrine of scepticism, and of a creation by blind chance. The Bible, indeed, must be our key to the study of all other evidences of like import, or we shall only wander more widely astray in devious tracks. We cannot, of ourselves, by searching, find out God, nor learn with any certainty of that great futurity on which our all depends. Nature

shows us what is, and tells us somewhat of what has been, but how little, indeed, will it reveal to us of what is to be. We see in the spring time the promises of harvest, but where shall we look for the evidences of that Great Harvest Home, whose reapers are to be the angels, and whose husbandman shall be the Almighty? This is the truth, ever to be kept in view, that whatever other truths may be learned elsewhere, it is in the word of God alone that life and immortality have been revealed to man.

SUMMER.

Summer is a coming in,
  Loud sing, cuckoo;
Groweth seed, a bloweth mead,
  And springeth the wood noo,
    Sing, cuckoo!

Ewe bleateth after lamb,
  Loweth after calf, cow
Bull sterteth, buck verteth;
    Merrie sing cuckoo!

Catch, written c. 1250.

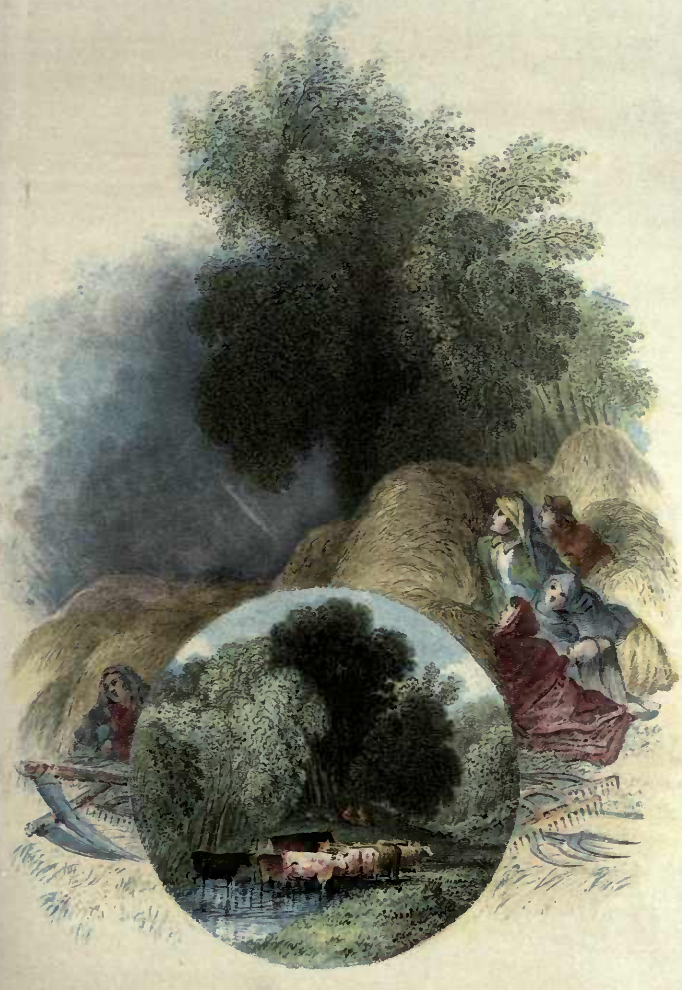
CHAPTER I.

THE MATURING.

A PLEASANT story is told by Mrs. Barbauld, of a youth who, rejoicing in the full play of healthful life and spirits, returned from a day of skating on the frozen pond, to tell his father that he wished it were always winter. The wise father made no comment on the boyish wish, but simply got him to write it down; and soon, amid the changes of the season, and varying occupations, all recollection of his wish had been forgotten. The spring came in with its milder breezes; the leaves began to come out on the trees, the early flowers to appear in the garden; the birds to build their nests, and the groves to thrill with the melody of their loves. Delighted with the change, young Henry could not help exclaiming to his father, as they walked forth together to enjoy the awakening beauties of nature, he wished that it were always spring. This also was noted down and forgotten. Summer came

with its delightful warmth, and its floral beauties, and autumn followed with its joyous harvest fields, and each in succession seemed to the happy boy more delightful than all that had preceded. At length, when he gave utterance to the wish, that the season of harvest, with its joyous reaping, and its abundant fruits should never cease, his father produced the record of his own successive wishes, and proved to him how little capable we are of ordering that which is best for ourselves, or of wisely comparing the present with the past.

We are not always wiser than the sanguine youth in our estimate of the changing seasons. To many the spring seems equally delightful, till it has been replaced by the warmer glow, and the full-blown maturity of summer. This, however, the student of nature learns, that each season has its uses, and its peculiar charms, and all are guided and controlled by wise beneficence. As the spring is the season of conception, the birth time and early youth of the year, so the summer is that of its maturity and manhood. Now it is that the purposes of the previous season become fully apparent. Wherever we turn we see beauty, strength, and vigorous life being manifested. The trees are in full leaf, the most gorgeous flowers are blooming. The plumage of the birds is in perfection, and nature seems everywhere clothed in her most beautiful attire. It differs, however, from the spring in its more gradual development; even as any birth necessarily comes upon us with a suddenness altogether contrasting with maturity. Each season has its uses, and contributes to the harmony of the annual course of time, on which the system of our world depends. According to the reckoning of olden writers, summer was not supposed to begin till the 21st of June, or the longest day of the year. Reckoning, however, according to ordinary computation, which begins the season with the month, we find its characteristics greatly differing from those of



SUMMER.

spring. The weather is now warm and genial, the showers rarer, and refreshing from moderating the heat, which occasionally becomes sultry and oppressive. The early flowers which adorned the parterres during the spring months, have nearly all disappeared; and the plants which then began to pierce the soil have now attained their full size, and are shooting forth clustering buds, expanding into luxuriant blossom. All nature partakes of this beauty. The rich blossoms of the heather are covering the moss and common, and furnishing a tempting supply to the industrious bee. The wild and rugged hill-side is now covered with the dog-rose, the honeysuckle, and the fox-glove in full bloom; and a thousand weeds and wild-flowers of varied aspect and hue, variegate the turf on common and hill-side. The garden is in like manner filled with every variety of cultivated flower. The eye feasts delightedly on their diversified forms and hues, and the air is fragrant with their rich perfumes. The earlier fruits are now also anticipating the harvest. The gooseberry, the currant and rasp, and the delicious strawberry, are all fully ripe; while the later fruits are formed, and the cherry already hangs invitingly on the tree. The lengthening day, and the increasing heat of the sun, mark the change from winter to spring, but this becomes much more apparent when that season has given place to summer. During the winter the sun rises in the east considerably towards the south, and passing through a circumscribed arc, again descends towards the horizon, being visible, in all, little more than seven hours out of the twenty-four. But a great change takes place as the year advances. The sun is gradually approaching the northern tropic, and as it continues each day to rise somewhat further towards the north, and to make a larger circuit through the heavens, the day becomes longer, and the heat even more intense. The day which formed so small a proportion of the twenty-four hours in the depth of win-

ter, becomes extended in our latitude in midsummer to fully seventeen hours. Within the arctic circle it never dips below the horizon, but converts the brief bright summer of the polar regions into one unbroken day. Even in the latitude of Edinburgh, the darkness of a clear midsummer night is never so great but that a book might be read without any great difficulty in the open air; and even so early as May, the pale light of dawn may be seen on the horizon very shortly after midnight. The sun, also, as it increases its path through the sky, rises at noon to a higher altitude, and pouring its rays more directly upon our northern hemisphere, exercises a much more powerful influence. The earth being thus exposed to a greatly increased heat, and through a longer period of time, a rapid accumulation of heat takes place; that which is given off during the night being greatly inferior to the accumulation during the day. Hence the excess of heat becomes stored, as it were, within the earth. During the winter the earth is rapidly giving off its heat, and the more equable temperature of the sea comes in, as we have shown in the previous section, to check the refrigerating influences, and to render insular countries, such as the British Islands, much more uniform in temperature than they otherwise would be. As the influence of the sun increases, and the duration of the night diminishes, the heat absorbed by the earth, and given off into the atmosphere, at length comes to be so much in excess that what is lost during the night is repaired in the morrow. When this balance has been attained, then it is obvious that, as the day still increases in length, and the sun continues to rise higher in the heavens, a great excess of heat must accumulate and be absorbed by the earth. Such is actually the case. So soon as the state of equipoise has been passed, each day's excess of heat penetrates deeper into the earth; and every time the solar influence is repeated, the accumulated heat is increasing, and reaching

farther from the surface, as well as raising the atmosphere to a higher temperature. As the period of equilibrium of heat and cold, beyond which the excess of the former is stored up as it were in the earth's crust, begins sometime before the sun has reached his highest altitude, so it is continued for a considerable time after he has begun his retrograde motion; and as the accumulation is thus continuing, while the actual solar heat is diminishing, and the day shortening, we have the remarkable annual phenomenon of the temperature continuing to increase, and reaching its highest maximum several weeks after the day has begun by its shortening, to give evidence of the decreasing influence of the solar luminary.

The chief cause of the more equable medium temperature of the sea, and of the extreme changes in that of the land, has already been explained as arising from the greater conducting power of the latter, so that the land both receives and gives off heat much more rapidly than the sea. Similar differences, however, in less degree, distinguish some conditions of land from others, and hence the immense importance of draining to the agricultural operations of our climate. So soon as the heat of the solar rays begins to penetrate into the soil, it gradually acts on the moisture which it contains, and exhales it in vapour; but in a moist, boggy, undrained soil, before the solar heat can raise the temperature sufficiently to dry up the superabundant moisture, rain sets in, the effect already produced by the sun's rays is counteracted, and the portion of the season of heat already passed, may be practically said to be lost. Such an alternating process goes on in this way throughout the season, a struggle as it were between heat and damp, in which the latter always triumphs; and hence it is that damp, boggy soils are so unproductive. The immediate effect of drainage is such as appears altogether marvellous to those who have not studied the operations of nature directly affected by it.

The superabundant moisture being carried off, and the excessive rains prevented from accumulating in the soil, the solar rays are at once enabled to act directly upon it, and instead of being wasted in raising the temperature of a useless moisture which it has not power to evaporate, it extends the radiation of heat deeper and deeper into the earth. So great is the change thus produced, that the temperature of a soil is frequently raised by this simple means six, seven, and even eight degrees. This, it is obvious, is nearly equal to removing the country some degrees further south, and the industrious agriculturalist reaps for himself the harvests of milder and more genial climates.

This and other important subjects connected with agricultural operations, have attracted the attention of Liebig and other distinguished continental chemists, as well as those of our own country; and Professor Johnston has shown, in his "Lectures on Agricultural Chemistry," under eleven separate heads, the great and varied advantages which arise from an effective system of drainage. "It has been calculated," says he, "that the drainage of those lands only which are at present in arable culture, (ten millions of acres,) would at once increase their produce by ten millions of quarters of the various kinds of grain now grown upon them; and that a similar drainage of uncultivated lands, (fifteen millions of acres,) would yield a further increased produce of twice as much more; so that a large superfluity of corn would be raised from the British soil."

But the effects arising from it, equivalent as they are to a change of climate, are not confined solely to the increasing returns of harvest. When an efficient system of drainage has been brought into operation over an extensive district, it is rendered altogether more salubrious as a residence for man. Ague and fever disappear with the miasmata by which they are caused; the general

health of the entire population is improved, and the duration of life extended. "Apart, therefore, from mere considerations of pecuniary profit, a desire to promote the general comfort and happiness of the entire inhabitants of a district, may fairly influence the possessors of land to promote this method of ameliorating the soil; while the whole people, on the other hand, ought 'gratefully to acknowledge the value of those improvements which at once render our homes more salubrious and our fields more fruitful.'"

A precisely opposite effect is seen to take place from similar causes in warmer climates. It has been observed, for example, in various districts of Southern Africa, that wherever either the natives or colonists have settled in a wooded district, or one where low plants and shrubs abound, and have destroyed the wood and cleared away the undergrowth for firewood, or by the treading and grazing of cattle, and the like, that the fertility of the soil is greatly affected, and sometimes a richly wooded district has been converted into a desert waste. Here, it is obvious, the effect of the trees and underwood has been to protect the soil from the direct rays of the sun, and thus to prevent the excessive evaporation of moisture, by which it at length becomes an arid waste, incapable of supporting vegetable life. In this manner we find a constant alliance and equalization going on in nature, and the operations of the same laws tending to the production of greatly varying effects, according to the local circumstances under which they are brought into play.

But besides the direct influence of excessive moisture in preventing the generation of heat, it also counteracts certain important chemical operations on which the healthy development of plants depends. The researches of modern chemistry have thrown much light on the nature of vegetable life, and on the physiology of plants. By direct analysis, the presence of certain constituents

is determined, while the amount of others becomes apparent on subjecting the whole to the effect of fire. "However completely any vegetable substance may be burnt, there always remains an ashy residuum unconsumed, which is the *inorganic* portion of its substance, contituting from one to twelve per cent. of its entire mass, and which is as essential to the integrity of the plant as is the larger proportion of *organic* principles. These inorganic compounds are alkalies and alkaline earths, and some metallic oxides, partly in combination with mineral acids which may remain undecomposed, and partly free, (after combustion,) though in the natural state of the vegetable, in combination with various organic acids, which are destroyed by the combustion we have supposed. Thus grapes contain in their juice much potash, in combination with an excess of tartaric acid, and it is from the juice of the grape, during its conversion into wine, that the commercial supply of the bitartarate of potash, or cream of tartar, as it is commonly called, is obtained. These mineral substances vary considerably in different plants, both in their nature and their proportions; but with the exception of such slight deviations as we before noticed, they are constant in plants of the same species.

"Potash, soda, and lime, in combination with silicic, sulphuric, and phosphoric acids, and likewise with some organic acids, as the oxalic and tartaric acids, form by far the largest proportion of the mineral constituents of plants. All the graminea, including the different kinds of corn, contain much silicic acid, (or silica, as it is usually called,) which is chiefly abundant in the straw, whilst the grain abounds in phosphates of potash, soda, and lime. Peas and beans abound in the phosphates of potash and soda, with lime and magnesia in smaller proportions. Potatoes have much potash both in their roots and tops, and the latter abound likewise in lime. Turnips contain

a considerable proportion of potash, and the leaves have much lime in combination with sulphuric and phosphoric acids.

"Such being found to be the constituents of vegetables, the chemical elements of these materials must be supplied to them during their life and growth, either in the same or some other forms of combination, and either in a gaseous state, or capable of solution in water, for only gases and liquids can be absorbed by plants.

"The air, rain water, and water from springs, &c., and the soil in which they grow, are the only media from which plants can obtain these supplies, for with these only are they in close contact.

"It may seem a statement somewhat startling, but is now well ascertained, that plants obtain from the air the largest proportion of their entire bulk. The composition of our atmosphere is 79 parts of nitrogen and 21 of oxygen in 100 parts, by measure, together with a small but constant and uniform proportion of carbonic acid, estimated at 1-2500th part of its volume, and a variable amount of watery vapour. Though the *proportional* amount of carbonic acid in our atmosphere is very small, yet the *total* quantity is very great; and, from the carbon of this carbonic acid, plants are capable of obtaining their whole supply of that element, which enters so largely into their composition. The entire amount of carbon contained in the carbonic acid of our atmosphere is estimated by Liebig at 3085 billions lbs.

"It is proved by the observations of numerous experimenters, Priestly, Sennebier, De Saussure, Sir Humphrey Davy, &c., that, whilst exposed to the sun-light, the green parts of healthy plants absorb carbonic acid gas from the atmosphere, and return pure oxygen gas to the air in nearly equal measure. Carbonic acid gas being a chemical compound of carbon with oxygen, the oxygen which is given off is that resulting from the decomposition of

the carbonic acid absorbed, the carbon of which is retained by the plants, and being made to combine with the elements of water, (which is abundantly supplied both from the soil and the atmosphere,) thus forms those organic principles which were previously mentioned as being composed of carbon and the elements of water, and which make up the greater part of the bulk of any vegetable."

Along with drainage as an indispensable source of agricultural improvement, the chemist by this means discovers the essential ingredients of plants, and ascertains thereby the fittest manure for preparing the soil for the growth of particular crops. By this means science has taught the application of the refuse of the stables, the waste part of certain crops, the use of mineral manures, and the general value of all the animal excretions, so large a portion of which has been hitherto allowed to run entirely to waste, or to remain an offensive and useless nuisance. Thus it is that a bountiful Providence preserves a proper equilibrium throughout the whole natural world, admitting of no real excess or waste. All things are undergoing change, but nothing is destroyed; nor have we evidence of the total annihilation of any created thing. Death indeed reigns throughout the animal and vegetable kingdoms, but life is ever springing from it; and that which appears to us most completely to pass away, is only resolved into its primary elements, to enter once more into new living forms.

CHAPTER II.

THE ATMOSPHERE.

THE mechanism of the atmosphere exercises too important a part in animal and vegetable life, and on the phenomena which are produced by the changing seasons, to be

overlooked in the consideration of the varied phases of nature. The ancients reduced all elementary principles to the four: air, earth, fire, and water, no one of which, it is now known, is truly elementary. They recognised, however, in the invisible atmosphere around us, a thing equally substantial with any of the others, and we now know it to be an atmospheric ocean, chemically compounded with certain elements of animal and vegetable life, and as essential to our locomotion, no less than to our vitality, as the waters of the sea are to the fish which swim in that denser element.

The body of gaseous matters which surrounds and incloses our earth as a vapoury sphere, presents to our eye the appearance of a vast dome, resting upon the encircling horizon, and rising to an undefined height above us. Its actual height, and its constituent elements, have been measured, guaged, and weighed; and its properties are now familiar to us. The atmosphere does not exceed fifty miles in its utmost height from the earth, but being an extremely elastic and compressible body, it increases in density as it approaches towards the surface of the earth, the lowest portion receiving the pressure of all above it, while the uppermost of this elastic vapour is only retained in connection with the rest of the earth's gaseous envelope by the force of attraction. The atmosphere consists of three gases, in nearly constant proportions, its chief constituents being nitrogen and oxygen, nearly in the relation of four parts of the former to one part of the latter, in addition to which there is always present a small but less constant proportion of carbonic acid gas, amounting on an average to about one part in a thousand of the whole. The air also holds a variable quantity of water in a state of vapour, generally amounting to about an hundredth part of the whole; and in addition to these various other matters, such as ammonia and other animal effluvia, or gaseous exhalations, are fre-

quently present. Its general composition is found the same throughout the globe, and its weight is so uniform as to afford a definite test by which to measure relative changes of elevation. "The pressure of the atmosphere decreases as we ascend above the earth's surface; and for equal ascents, this decrease of density is in what is called geometrical progression. Thus, at three miles in height, the density of the atmosphere is only one half of what it is at the surface of the earth, or equal to a column of mercury fifteen inches in height; at six miles, the barometer would stand at one-fourth of its usual height, or seven and a half inches; at nine miles of elevation, at three inches and three quarters; and, at fifteen miles, nearly at one inch only. Hence by far the greater portion of the atmosphere is always within fifteen or twenty miles of the earth's surface; though from various circumstances it has been inferred to extend from forty to forty-five miles in height. This height, however, must be different in different latitudes; for the rotation of the earth upon its axis, and the greater and more direct influence of the solar heat upon the earth's equatorial regions, will necessarily cause the atmosphere to be higher there than in the polar regions; at the poles, the atmosphere must be lower than over any other part of the earth's surface. These are most important circumstances in the economy of nature."

The whole economy of terrestrial creation is affected by these atmospheric influences. This invisible element which surrounds us, and incloses the earth, like an elastic rind, exerts a pressure or weight upon the earth's surface, and all bodies fixed or moveable thereon, equal on an average to about fifteen pounds on a square inch.

The idea of attempting to ascertain the weight of air, or otherwise testing its composition, was regarded at no very remote period as an absurdity, only to be classed with the poet's ideal of extravagance, "to gild gold, or add

another hue to the rainbow." Pepys, the secretary of the admiralty in the reign of Charles II., gives in his diary an amusing account of the king's mirth at the supposed folly of the philosophers of his day, in attempting to ascertain the weight of the atmosphere. "I to Whitehall;" says Pepys, "there in the Duke's chamber, the King come and stayed an hour or two, laughing at Sir W. Petty, who was there, and at Gresham College in general: at which poor Petty was, I perceived, at some loss; but did argue discretely, and bear the unreasonable follies of the King's objections and other bystanders, with great discretion. Gresham College he mightily laughed at, for *spending time only in weighing of ayre*, and doing nothing else since they sat."* Many things, however, which folly has laughed at, have since been found to repay the researches of the wise; and among these, air has not only been weighed, but analyzed, and shown to be no simple element. Its weight also is made subservient to other truths, and the measurement of it, by means of the barometer, is simply weighing it with a counterpoise of ascertained weight, the result of which is the establishment of the well-ascertained rule, that the atmosphere is equal in weight to a column of mercury, one inch square and thirty inches high. To this element in which we live and move, all our functions are adapted. We move under this weight pressing on every part of our body, with the force of fifteen pounds to the square inch. Our lungs play, our blood circulates, and our limbs move, all in accordance with this power; and so completely is the balance preserved between our bodily constitution and the pressure of weight of this our natural element, that the ascent to the summit of an unusually high mountain, is attended with a sense of great discomfort, accompanied with the swelling of the veins, and sometimes bleeding at the nose, and other equally violent symptoms of the disturbance of

* Diary of Samuel Pepys, 3d Edit. vol. ii. p. 277.

the harmonious balance between our frame and its natural element; while the opposite excess is shown on descending in a diving-bell to any great depth in the sea, where the compression of the air by the superincumbent column of water, is attended with violent headache, and a painful feeling of pressure on the head.

But the mere mechanical weight of the atmosphere, though thus so important an element of animal life and motion, and furnishing moreover the medium on which the essential motions of so large a section of animated nature—the birds—depend, is only one of the secondary influences which flow from its characteristics. It is compounded mechanically of chemical elements, which are so adjusted as to furnish the most essential supplies requisite for animal and vegetable life, while the several compounded elements are such that a comparatively slight disturbance of this adjustment would convert the air we breathe into a deadly poison, and sweep the earth with a destruction more sudden, and no less fatal, than that of the universal deluge. Towards the constant adjustment of this invisible fluid it is probable that the changing temperature of the seasons contributes in part, maintaining the nice balance on which life depends, by the motion which, owing to the alternations of heat and cold, is ever going on. The effect of heat is also abundantly apparent in effecting the intermixture of moisture with the other ingredients of the atmosphere. By means of heat, the water is evaporated from the earth, and intermingled with the air, sometimes as an invisible vapour, and at other times in the form of clouds, which accumulate until they precipitated in rain. The atmosphere is capable of containing a certain amount of vapour in proportion to its temperature, and hence evaporation goes on to a great extent during the heat of summer. A change of temperature does not, however, arrest this important process, though it diminishes its extent. The temperature in

winter is such as greatly to diminish the power by which water is held in solution in the atmosphere, but even in the coldest weather evaporation goes on, until the air is saturated, and then deposition takes place ; nor does rain or snow fall, either in summer or winter, till the atmosphere has thus become surcharged. Here again, however, the wonderful provisions of creative wisdom become apparent, in the adaptation of this law to the variations of the seasons, and of different climates. Though deposition cannot take place till the air is super-saturated with moisture, this takes place at very different temperatures, according to the capacity of the atmosphere as affected by the degree of heat, and hence a very slight fall in the temperature suffices to form clouds, and cause a fall of rain in summer, compared with what is requisite to produce the same results in winter. Hence it is that the processes of evaporation and deposition of moisture, go on throughout the year, varying greatly in the phenomena which they produce in different climates, but in all so adjusted to the temperature of the season, as to supply all the requisite elements for healthful continuance of animal and vegetable life.

It is difficult to conceive of more wonderful evidence of divine wisdom, as manifested in the adjustment of means to such complicated ends. It presents to us a problem surrounded with a thousand difficulties. The atmosphere on which the play of our lungs, the use of our visual and auditory organs, the action of our limbs, and all our motions depend ; which is as indispensable to vegetable as to animal life; and largely affects even inanimate nature, influencing every impulse given to inert matter ;— this atmosphere, by means of which we see, hear, and breathe, would seem to be susceptible of such numberless changes, that its constancy must be uncertain for a single day. So mobile is it that it pulsates, vibrating to the slightest sound ; every change of temperature affects it,

the flowers breathe into it new odours, the stagnating pools, and the decay of animal and vegetable matters, exhale poisonous gases to mingle with its elements; and in every latitude of the globe, with every change of season, diversified modifications are produced. To human wisdom, therefore, the adjustment of such an element to a constant standard compatible with the sustenance of animal and vegetable life, would seem altogether impossible; while to the philosopher who denies the superintending care of Providence, the existence of living beings in such a medium, would seem more precarious than that of the dweller amid the dead and dying in some city of the plague. The main ingredients of the atmosphere, as we have already stated, are nitrogen and oxygen, or vital air. These two gases, possessed of extremely different properties, are only held together by mechanical admixture, and any change greatly affecting their relative proportions of seventy-nine parts of the former to twenty-one parts of the latter, would at once render the compound incapable of sustaining life. Yet we live within this nicely balanced ocean of air, in perfect confidence and in perfect safety, while the changes and revolving seasons of six thousand years, have never overthrown its delicate equilibrium, or affected its universal adaptation to the requirements of life. It is, indeed, subject to oscillations. The changes of temperature, on which the seasons depend, produce other effects besides those above described. The winds are the result of the atmosphere set in motion by variations of heat and cold. As the air becomes heated, it ascends, creating a vacuum which is replaced by an under current, which produces the land and sea breezes on the coast, in warmer latitudes; the trade winds, by the constant rush of the colder air from the poles to the equator; and, modified by various other causes, all the varying winds of the temperate zones All these oscillations, however, are restrained within narrow

bounds, and even in their most violent deviations from their mean state, the derangement is transient and local, and circumscribed by a very limited area.

That the whole atmospheric phenomena to which we have referred, are the result of fixed laws, is abundantly obvious; but that all these are sustained by that over-ruling First Cause to which we trace their origin, is no less apparent by those phenomena which excite the admiration of the devout student. "If the atmosphere," says Dr. Whewell, "be considered as a vast machine, it is difficult to form any just conception of the profound skill and comprehensiveness of design which it displays. It diffuses and tempers the heat of different climates; for this purpose it performs a circulation occupying the whole range from the pole to the equator; and, while it is doing this, it executes many smaller circuits between the sea and the land. At the same time, it is the means of forming clouds and rain; and, for this purpose, a perpetual circulation of the watery part of the atmosphere goes on between its lower and upper regions. Besides this complication of circuits, it exercises a more irregular agency in the occasional winds which blow from all quarters, tending perpetually to restore the equilibrium of heat and moisture. But this incessant and multiplied activity discharges only a part of the functions of the air. It is, moreover, the most important and universal material of the growth and sustenance of plants and animals; and is for this purpose everywhere present, and almost uniform in its quantity. With all its local motion, it has also the office of a medium of communication between intelligent creatures, which office it performs by another set of motions, entirely different both from the circulation and occasional movements already mentioned; these different kinds of motions not interfering materially with each other; and this last purpose, so remote from the others in its nature, it answers in a manner so perfect and so

easy, that we cannot imagine that the object could have been more completely attained, if this had been the sole purpose for which the atmosphere had been created. With all these qualities, this extraordinary part of our terrestrial system is scarcely ever in the way; and when we have occasion to do so, we put forth our hand and push it aside, without being aware of its being near us."

On this remarkably constituted fluid, the action of heat is no less remarkable than the other phenomena to which we have referred. Finding the great heat which the atmosphere acquires in midsummer, in the lowest strata in immediate contact with the earth, it would seem entirely consistent with reason to expect that the higher we ascended in it, its greater nearness to the sun should expose it to an increasing temperature, so that on its outer surface at a height of nearly fifty miles, it would be found insupportably warm. Yet the very opposite we know to be the case, and the ascent even of two or three miles in height is equivalent to an advance of several degrees near the pole. The rays of the sun in passing through the air, do not increase its temperature. It is not until they reach the opaque surface of the globe that heat is generated, and the atmosphere thence receives it by reflection. As the accumulation of this heat depends on the length of time during which its radiation is continued, we have here one important source of the increasing summer heat, and of the evaporation then constantly going on, by which so many important ends in the economy of nature are secured.

CHAPTER III.

GROWTH OF PLANTS.

The interesting processes which accompany the first development of life in the seed, have already attracted our notice among the phenomena peculiar to the season of spring; we shall now consider the further progress of the plant as it is seen in the succeeding summer time, when the full warmth of the sun, and the most genial influences of the year unite to bring it to maturity.

The primary classification of the vegetable kingdom is into what are called *Exogenous*, and *Endogenous plants*. The *Exogenous* class are so named because their woody matter is augmented by additions to the outside of the first central formation, while the *Endogenous* plants increase entirely by internal augmentation. The *Exogens* are by far the most numerous, and include nearly all the trees of the temperate zones, and those which we are most familiar with in northern regions, such as the oak, the elm, the ash, the beech, and the whole fir tribe. While the *Endogens* include many of the most characteristic tropical trees; such as the various palm trees, the date, the cocoa-nut, the bread-fruit tree, &c., and also the sugar-cane, the bamboo, and all the numerous plants of the same class.

The growth of endogenous plants may be first referred to as the least complicated of the two natural processes of increase. Dr. Roget has thus illustrated the different processes by which these two remarkable divisions of the vegetable kingdom are distinguished, selecting as the fittest example of the growth of endogens, the palm tribe. "The stem of a palm tree is usually perfectly cylindrical, attains a great height, and bears on its summit a tuft of leaves. It is composed of an extremely dense external cylindric layer of wood; but the texture

of the interior becomes gradually softer and more porous as it comes nearer to the centre; though with regard to its essential character it appears to be uniform in every part, having neither medullary rays, nor true outward bark, nor any central pith; in all which respects it differs totally from the ordinary exogenous trees.

"The first stage of its growth consists in the appearance of a circle of leaves, which shoot upwards from the neck of the plant, and attain, during the first year, a certain size. The following year, another circle of leaves arises; but they grow from the interior of the former circle, which they force outwards as their vegetation advances, and as ligneous matter is deposited within them. Thus each succeeding year brings with it a fresh crop of leaves, intermixed with ligneous matter, which leaves, exerting an outward pressure, stretch out the preceding layers that enclose them; until the latter, acquiring greater density, no longer admit of further distention, and remain permanently fixed. This happens first to the outermost layer, which is the oldest: then each succeeding layer becomes consolidated in its turn. As soon as the outer layer has become too hard to yield to the pressure from within, the growth of the inner layers is immediately directed upwards; so that they each rise in succession by distinct stages, always proceeding from the interior; a mode of development which has been compared by De Candolle to the drawing out of the sliding tubes of a telescope. The whole stem, whatever height it may attain, never increases its diameter after its outward layer has been consolidated. A circle of leaves annually sprouts from the margin of the new layer of wood; these, when they fall off in autumn, leave on the stem certain traces of their former existence, consisting of a circular impression round the stem. The age of the tree may accordingly be estimated by the number of these circles, or knots, which appear along its stem."*

* Roget's Animal and Vegetable Physiology, vol. i. p. 83.

The same rule applies to the whole tribe of palm trees, and the other larger plants of the same class; and though in the smaller ones, the successive additions do not mark the annual growth, they are the test of the progress the plant has attained; as in the various bamboos and canes, where the successive pauses and new shootings of the plant, are permanently marked, as on the endogenous trees. To this class of plants also belong the various grasses; and the successive knots which indicate their progress are seen as distinctly in the growing corn, as in the stout bamboo, or the lofty palm: the straw being indeed but a feebler and smaller bamboo. Grasses may indeed be most simply described as endogenous plants with hollow stems, strengthened by transverse plates at the nodes: including in such definition the largest reeds and bamboos. They differ in this respect from endogenous plants of slower growth, the rapidity of their development being apparently the sole cause of this peculiarity. The deviation appears to arise from the circumference growing so much faster than the centre, that the latter is forced apart, and forms into a fistular passage. The development of this process may be readily observed in the gradual change which the various grasses undergo, in the transition from the young germ as described in the cereal plants of spring, and the full grown corn or wheat of summer, when the ear is already formed, and is rapidly filling and ripening for the autumn harvest. So long as the grasses grow slowly, during the earlier spring season, their stems are solid, like those of the palm trees; but when this period is past, and they hasten towards their full development, then comes the acceleration of growth of the outer portions, by which they are changed into hollow reeds or straws, except at the nodes, where the arcs of ligneous tissue, originating in the leaves, cross over and form a division in the stem, as is familiar to us in all the bamboos, as well as in the straw of the common grasses. This serves

greatly to strengthen the hollow stem, and to bind it together so as to prevent a rupture.

Nearly the whole varieties of endogenous plants and trees, are capable of only a very limited duration, when compared with the exogenous trees. A minute microscopical investigation of the internal structure of some of the palms, has led botanists to the conclusion, that the woody fibres which appear in little bundles, crossing each other, or lying parallel within the central column of an endogenous stem, are in reality roots emitted by the leaves, which plunge downward through the cellular substance of the stem, drawing thence the requisite nourishment for the leaf. In the screw pine, a singular phenomenon is observable, where stems shoot downward from the main trunk, and when they reach the earth, the woody bundles divide and form into roots. This however appears, on closer investigation, to be only a variation of the common phenomena attending the growth of endogenous trees; for, on making a longitudinal segment of the stem of a palm tree, the woody fibres, which terminate in the leaves, may be traced downward through the central column.

The manner of growth peculiar to all endogenous plants and trees, gives them a marked character, not readily mistaken. The trunks of endogenous trees are usually straight, like a column, and of nearly uniform thickness throughout. Their leaves are also invariably large, generally shaped like a broad sword blade, or, still more gracefully, as a wide serrated fan, in some cases from twenty to thirty feet wide. In no case, however, are these borne on separate branches, the largest of the palm trees being in this respect only a gigantic grass.

From two to three hundred years has been estimated as the utmost extent of life, of nearly all the best known endogenous trees, such as the date and other palms; and many of them are of greatly briefer longevity. The cir-

cumference of their stems being limited specifically, it is obvious that the height to which they can attain, must bear some proportion to this, in order that the stem may be able to sustain the majestic plume of leaves which usually crowns the summit. But where, as in a very few varieties, the stem increases in diameter as well as in height, no limit appears to be assignable to their growth or duration. The famous dragon tree of Oratava in Teneriffe, which is of this latter class, has been repeatedly figured and described. It was an object of admiration for its immense size, and great and unknown antiquity, in the very beginning of the fifteenth century; and now after a lapse of four hundred and fifty years, it is still alive, and exhibits no evidences of decay. This remarkable variation from the ordinary laws, which seem to bind down nearly the whole family of endogenous plants to a rapid development, and a brief duration, would seem to confer on it a means of longevity, to which no precise natural limitations are assignable, as a constant renewal is going on by means of its process of growth, such as may render the duration of our most venerable oaks, through centuries of our national history, but an ephemeral continuance of vitality when compared with these undecaying trees.

While the endogenous plants thus comprehend a large number altogether unknown among the natives of temperate latitudes, and which are equally strange and useless to us, the class includes also some of the most valuable plants; and indeed, compared as a whole with exogens, they probably contain a larger proportion of plants contributing directly to the food of man, and also fewer poisonous species in proportion to their whole number. The family of grasses, with their valuable nourishing albumen, forms a large portion of the class of endogens; and to these have to be added the no less useful growth of tropical latitudes, the palms, which yield, in addition

to their large and nutritious fruits, wine, oil, sugar, sago, araceæ, amaryllidaceæ, &c., producing arrow-root, and various aromatic and nourishing secretions; while their acrid or poisonous secretions are extremely few and unimportant. Endogenous plants, however, are comparatively few in number, and have been computed by De Candolle as bearing to the exogenous plants a proportion of little more than one to six. In these, as in the other natural orders in which the divisions of the vegetable kingdom are classified, we find extreme varieties, and learn to recognise a common principle influencing the growth of the tiny stalk of grass and the giant palm tree, which lifts its clustered tuft of leaves an hundred feet high. So also the scientific botanist teaches us to class the little asparagus, reared in a few months in our kitchen gardens, with the gigantic dragon tree, which may endure beyond the sum of years from which we date the beginning of our era. In like manner we find at one extreme of this endogenous organization of vegetable life, palms, plantains, and arborescent liliaceous plants; while at the other we meet with the duckweed, which has not even the distinction of leaf and stem, yet bears, notwithstanding, sufficiently marked characteristics to leave no doubt of its proper classification. The whole of these plants and trees to which we have referred, partake exclusively of the endogenous mode of growth, which, as will appear by comparison with that which we are now to consider, is the simplest of the two kinds of vegetable growth.

The more complicated structure of exogenous plants and trees, exhibits, when fully developed, two principal parts, the *wood* and the *bark*. The former is again further divisible into the *pith*, which always occupies the centre, and consists of a light and spongy texture, readily permeable by liquid or the air; outside of this is the true or *hard wood*, surrounding the pith in a series of concen-

tric rings; and this again is inclosed by a softer wood, or *alburnum*, as it is called, which is in like manner composed of a series of concentric layers. The bark is also formed of a series of concentric layers, and is further subdivided into various portions, which it is not requisite to enter into more minutely here.

The whole of this elaborate structure is beautifully shown by means of the horizontal section of the stem of a tree. In this may be seen all the various concentric layers, from the outermost envelope of the bark, called the *epidermis*, to the central pith or core. Besides these concentric zones, the section also presents a number of large cells, radiating from the centre towards the circumference, which bear the name of *medullary rays*. These transverse cells compose, by their union, continuous vessels for conducting the sap and nourishment from the roots, through every part of the trunk and branches, to the outermost twig and leaf; and thus a healthful and vigorous circulation of what may be termed the life-blood of the tree is kept up, like the flow of our own warm blood through all the veins and arteries of our frame. This is the animation which the spring revives and calls into activity throughout the whole vegetable kingdom, and which is in its fullest vigour throughout the whole season of summer, contributing as essentially towards the maturity and multiplication of every form of vegetable life, as the various instincts of the insect and animal kingdoms, to which we have referred in former chapters, do towards the preservation of this various species, and the reproduction of the animated life which is seen in the full enjoyment of nature on each returning season.

The processes of growth and development in the great natural division of exogens are no less interesting and instructive, as evidences of Providential foresight and wise design, than any department of nature to which our attention has yet been directed. "Every vegetable stem,

and also every branch which arises from it, is developed from a germ, or bud, which is originally of inconceivable minuteness, and totally imperceptible by any optical means of which we have the command. As soon as it becomes visible, and its structure can be distinguished, it is found to contain within itself the parts which are to arise from it, in miniature, and folded up in the smallest possible compass. The portion destined to form the stem is gradually expanded both in breadth and height, but principally the latter, so that it rises as it grows, during a certain period, until the fibres acquire the solidity and strength necessary not only for their own support but also for sustaining the parts which are to be further added. In trees this process generally occupies one whole season; during which the growth of the first layer of wood, with its central pith, and its covering of a layer of bark, is free and unrestrained. In the second year, a fresh impulse being given to vegetation, a new growth commences from the upper end of the original stem, as if it were the development of a new bud; and at the same time a layer of cellular tissue is formed by the deposition of new materials on the outside of the former wood, and between it and the bark. This is followed by a second layer of wood, enveloping the new layer of cellular tissue.

"The effect of this new growth is to compress the layer of wood which had been formed during the first year, and to impede its further extension in breadth. But as its fibres, consisting of vessels and cells, are not yet consolidated, and admit of still greater expansion as long as they are supplied with nourishment, their growth, which is restrained laterally, is now directed upwards, and there is no farther enlargement of their diameter. From the same cause the pith cannot increase in size; and is even found to diminish by the pressure of the surrounding wood. Thus the vertical elongation of the entire

stem continues during the whole of the second year, and the trunk becomes sufficiently strengthened by the addition of the second layer on its outside to bear this increase of its height."*

A corresponding change takes place at the same time on the outer covering or bark. By a like process it receives an increase on its inner surface, by which the outer layer is stretched and compressed, until at length it becomes so rigid as to be incapable of yielding further as an elastic substance, when it gives way partially throughout, producing the deep cracks with which we are familiar on most trees, such as the oak, the elm, the ash, &c. Even in this simple result of a similar cause operating upon all, we observe how much the nature of each species modifies the action of general laws, for the bark of each tree cracks in its own peculiar way, so that to any one in the least degree familiar with the appearance of these various trees, the species could readily be determined from seeing the trunk or a single branch, though entirely destitute of leaves. "During the third and each succeeding year," continues Dr. Roget, "the same process is repeated; new layers of cellular texture and of woody fibres are deposited around those of the preceding year's growth, and a new internal coating is giving to the liber of the bark. The compressing power continues to be exerted on the internal layers of wood, directing their growth vertically, while they are capable of elongation, and can be supplied with nourishment. In time, however, by continued pressure, and accumulating depositions of solid matter, the vessels and the cells become less and less pervious to floods, till at length all further dilatation is prevented. But the tree still continues to enlarge its trunk by the annual accessions of vigorous and expansible alburnum, and to take its station among its kindred inhabitants of the forest; till, arriving at maturity, its

* Roget's Animal and Vegetable Physiology, vol. i., p. 86.

majestic form towers above all the junior or less vigorous trees.

"The development of each branch takes place in the same manner, and by the same kind of process, as that of the trunk. The buds from which they originate, spring from the angle formed by the stalk which supports a leaf, and which is termed by botanists the *axilla* of that leaf. A law of symmetry is established by nature in the development of all the parts of plants. The leaves, in particular, are frequently observed to arise in a circle, or symmetrically round the parent stem; forming what is termed a *whorl*, or, in botanical language, a *verticillated* arrangement. In other cases they are found to have their origins at equal intervals of a spiral line, which may be conceived to be drawn along the stem, or the branch from which they grow. When these intervals correspond to the semi-circumference of the stem, the leaves alternate with one another on its opposite sides."*

The horizontal sections, to which we have referred, furnish a most interesting series of illustrations of the various processes of development; but sufficiently thin to be translucent, they present, under a powerful microscope, a minute network of cells and sap vessels, showing the wonderfully elaborate, yet orderly system by means of which the whole is developed and brought to maturity. The same sections also, cut solid, and polished, both from the roots and branches, may be made to illustrate the annual progress of the plant. The difference between such sections at one, two, and three years old, is very considerable. It is well known, also, that a tolerably accurate approximation to the age of certain trees may be made, merely by counting the concentric rings which appear in a horizontal section surrounding the core. The causes which operate to cause this distinct indication of the product of each year's growth, instead of the whole

* Roget's Animal and Vegetable Physiology, vol i., p. 69.

being blended into a homogeneous texture, admit of easy explanation. The ligneous tissue formed in exogenous trees at the beginning of the season, when the sap begins to rise and flow in great abundance, is open and porous compared with the compact tissue which is produced towards the end of the season. As this latter compact tissue comes into juxtaposition with the earliest and most cellular product of the following spring, the difference in the density is strongly marked, and thus the tree preserves as it grows a record of its progress, and an accurate registry of its age. The same reason also suffices to show how it is that the pines grown in the bleak mountain forests of Norway are superior in value to the fir of milder and more southern latitudes. Exposed as these are to a rigorous climate, their growth is slow, and the sap rises during only a brief period of the year, forming a small but compact and very firm addition; and thus when the tree reaches maturity, its wood is close-grained, hard, and durable, when compared with the more open cellular tissues formed by the more abundant sap which rises throughout the earlier spring and protracted summer of warm climates. This test of annual growth is not, however, by any means of universal application. Indeed, the total absence of regular concentric circles is extremely common in the wood of tropical countries, and the cause already assigned for their annual variations in the degree of compactness, will readily suggest to the intelligent reader a reason for no such registry of age being traceable in many even of the most regularly formed tropical woods. If the climate be so nearly equable throughout the year as to expose the plant to no such decided variations of influence as mark the extremes of our summer and winter, then the tissue of wood formed at all seasons will be so nearly alike, that no zones or circles of the growth of a season will be observable, although the wood is produced entirely by the same

exogenous process as that which stamps the trunk of the oak or elm with the indelible record of its progress.

It would be easy to enlarge on the various remarkable evidences of design, and of adaptation to peculiar climates and localities, as well as to numerous uses, which are traceable throughout the remarkable phenomena of the vegetable kingdom described in this chapter; but it is sufficient to point them out, and to leave the reader to apply his own conclusions. The further our investigations into the interesting field of research thus indicated are pursued, the more will he be struck with the endless variety of design by which nature demonstrates to us, in every department of the divine works, the inexhaustible fulness of the Creator.

CHAPTER IV.

THE FLOWER.

In pursuing the natural course of our subject, we are now led to the consideration of those natural forms in which, it would seem, as if the Creator had delighted to expend with the greatest profusion the elements of grace and beauty. We perceive in the corn or wheat; in the cabbage or parsley; and in the fig or pine tree, how effectually all the purposes of growth, fructification, and reproduction, may be secured in the vegetable kingdom, without any such display of fragrance or beauty as mark so many other varieties of the productions of the vegetable world. Here also the inexhaustible power of the Creator is most wonderfully apparent, and exhibited also in a manner peculiarly comprehensible to the simplest capacity. "The stars," says Whewell, "which we see with the naked eye, are but a very small portion of those which the telescope

unveils to us. The most imperfect telescope will discover some that are invisible without it; the very best instrument perhaps does not show us the most remote. The number of stars which crowd some parts of the heavens is truly marvellous: Dr. Herschel calculated that a portion of the milky way, about 10 degrees long and 2½ broad, contained 258,000. In a sky so occupied, the moon would eclipse 2000 of such stars at once.

"We learn too from the telescope that even in this province the variety of nature is not exhausted. Not only do the stars differ in colour and appearance, but some of them grow periodically fainter and brighter, as if they were dark on one side, and revolved on their axes. In other cases two stars appear close to each other, and in some of these cases it has been clearly established that the two have a motion of revolution about each other; thus exhibiting an arrangement new to the astronomer, and giving rise, possibly, to new conditions of worlds. In other instances again, the telescope shows, not luminous points, but extended masses of dilute light, like bright clouds, hence called *nebulæ*. Some have supposed that such nebulæ, by further condensation, might become suns; but for such opinions we have nothing but conjecture. Some stars, again, have undergone permanent changes; or have absolutely disappeared, as the celebrated star of 1572, in the constellation Cassiopea.

"If we take the whole range of created objects in our own system, from the sun down to the smallest animalcule, and suppose such a system, or something in some way analogous to it, to be repeated for each of the millions of stars which the telescope reveals to us, we obtain a representation of the material universe; at least a representation which to many persons appears the most probable one. And if we contemplate this aggregate of systems as the work of a Creator, which in our own sys-

tem we have found ourselves so irresistibly led to do, we obtain a sort of estimate of the extent through which his creative energy may be traced, by taking the widest view of the universe which our faculties have attained.

"If we consider further the endless and admirable contrivances and adaptations which philosophers and observers have discovered in every portion of our own system; every new step of our knowledge showing us something new in this respect; and if we combine this consideration with the thought, how small a portion of the universe our knowledge includes; we shall, without being able at all to discern the extent of the skill and wisdom displayed in the creation, see something of the character of the design, and of the copiousness and ampleness of the means which the scheme of the world exhibits."*

Yet, quitting this comprehensive theme, in which the imagination wanders amid vain strivings to grasp at the comprehension of distances, masses, and relations of world-systems to each other; if we only investigate with sufficient minuteness the wild flowers of the field, we shall find abundant subject for devout contemplation on the inexhaustible wisdom and beneficence of the Creator, and on "the fulness of Him who filleth all in all."

Whether we contemplate the variety and beauty of form which flowers everywhere exhibit, the splendour of their colours, the delicious fragrance which they exhale, or the wonderful delicacy and elaborate provisions for every function of life in their construction, we are alike filled with a sense of wonder and admiration at the display of wisdom and inexhaustible creative design. It, doubtless, makes the devout student of nature contemplate with a livelier sense of humility his own place in creation, when he forms some intelligible idea of the vastness of that universe, amid which our world itself appears but as a grain of dust amid the myriad stars. Yet, quitting these

* Whewell's Bridgewater Treatise, p. 271.

stars in the azure vault of heaven, let us look for a moment on the very smallest of those which sparkle amid the grass at our feet. If we pick up one even of the most humble, insignificant, and apparently inattractive: such, for example, as the chickweed, or any of the smaller more microscopic asters, and examine it closely, we find an organization as wonderful as our own. It has its capillary tubes, its vessels through which the sap circulates; its leaves, through which a complete system ramifies, carrying the needful supply of life-giving sap, and respiring as regularly as the healthful animal. Its flower, also, when submitted to a magnifying glass even of very limited power, is no less beautiful in form and complete in all the singular organs essential to the continuance of the species, than the largest and most gorgeous of tropical plants. The astronomical argument testifies to the greatness of God; but, contemplating him only in that aspect, we are apt to feel as if we were too insignificant to command his notice, or excite his displeasure by our neglect of his laws. But, when we find that the wild weed, which seems to us unworthy of notice, is not beneath his care, we discern the whole force and beauty of that divine assurance of providential care proclaimed to to us in the beautiful and forcible appeal:—"If God so clothe the grass of the field, shall he not much more clothe you, O ye of little faith?" It is not without reason that an argument has been derived from the fragrance and beauty of the flowers, in proof of the benevolent designs of God in the adaptation of them to our senses. Their form, colour, and fragrance, all minister to our tastes. The sense of beauty which leads even the savage to adorn his paddle or war-club with fanciful designs, finds in the most cultivated habits of mind which education engenders, no higher forms of beauty attainable than those which we imitate even from the flowers or leaf of some of our commonest weeds. We are not justified in concluding

absolutely that the fragrance and beauty of the flowers are altogether lost on the lower animals. The butterfly and the bee may enjoy pleasurable sensations from the fragrance of the plants, as well as from the honey and sweet juices they extract from their flowers; and the flocks that graze on the meadows may derive a sense of pleasure from the aroma of the flowers and the sweet smell of the new mown hay. This, however, is certainly at best vastly inferior in kind, and greatly limited in degree; and probably only suffices to guide the instincts by which they are taught to select the most nourishing and suitable food. As a means of simple enjoyment and a source of innocent gratification to the senses, flowers seem to be specially adapted for the benefit of man. The senses of smelling and seeing, in addition to their essentially practical uses, serve to convey highly pleasurable sensations to the mind, derived from this abundant source, by which a great amount of innocent and healthful pleasure is made to contribute to the sum of human enjoyment. That it is no indispensable concomitant of the existence of vegetable life is sufficiently apparent. Many plants and flowers have no smell; and some have odours alike irritatingly pungent, or rank and offensive. These, however, are so essentially exceptions to the rule, that the mind invariably associates ideas of grace and beauty, and of fragrance, with flowers. It is, moreover, worthy of notice, that the beauty of colour and richness of odour in the flowers, address themselves to the most universal sympathies of our common nature. The want of refinement which accompanies the absence of education, is, indeed, apparent in a certain blunting of the senses, so as at least to be indifferent to the offensiveness of odours which would be unpleasant to refined tastes, and unconscious of the finer gradations of colour and form which the educated eye traces in the flowers of the garden and field; still the most uninstructed is capable of deriving much

enjoyment from them; as may be seen in the glee with which a group of town-bred children employ themselves in culling a garland of wild flowers, when they have chanced to escape on a summer holiday from the smoky alleys of the pent-up city.

But we must also recognise a no less remarkable proof of such benevolent adaptation of the vegetable kingdom to the faculties of the human mind as to render it an inexhaustible source of enjoyment, in the fact that the harmonious proportions and the beauty apparent in the tints and forms, and the whole growth and structure of flowers, supply the highest enjoyment to the most cultivated minds. The brilliancy of the poppy and the glare of the sun-flower, attract at once the untutored admiration of the child; but the most intelligent and cultivated understanding is best fitted to appreciate the delicacy of the hues of the flowers, the variety of their tints and the imperceptible gradation of hues by which they are blended into each other, or variegated by striking contrasts of form and colour. All this, in so far as it is created with a view to produce intelligent enjoyment, is designed for the use of man alone, and calls for our admiration and gratitude, in acknowledging the Divine goodness in thus so liberally administering to our happiness. While, however, we thus recognise a design for our own enjoyment in these combined characteristics of the wild flowers scattered in such profusion over hill and dale, and infer from thence the existence of condescending goodness, as well as infinite wisdom and skill, in their bountiful Creator, we must also remember how very secondary an object in the creation of all these lovely and fragrant blossoms our own enjoyment must have been. We gaze with delight on the bank clustering with the scented thyme and violet, and festooned with the bramble and lovely dog-rose, blushing with its thousand expanding buds. A day would scarcely suffice us to number and classify every species within our

sight, much less to reckon the countless multitude of blossoms which gladden the eye and perfume the air. It seems an act of presumption to assume, when we meet in some sequestered dell with such a galaxy of beauty, that all this has been created for the momentary pleasure of a chance wayfarer like ourselves; but if thousands thus blossom only within reach of some rare wanderer's eye, tens of thousands more "are born to blush unseen, and waste their sweetness on the desert air." These, therefore, are created for other purposes than the use or enjoyment of man. Their fragrancy fills the air without ministering to his pleasures, though every leaf and bud supplies a source of joy, and means of subsistence to myriads of living creatures, each in its degree capable of partaking of the happiness thus provided for it. The nectaries of numerous flowers seem to be expressly created for the secretion of honey, the delicious food thus providentially provided for so large a portion of the animal kingdom; and which, when stored up in quantities by the bee, forms so acceptable an addition to the luxuries of the table. The store of honey lies deep within the corolla of the flower, and below the ovary, to which it is perhaps also of some essential use. But the bee, and most other insects, are provided with an instrument which may be not inaptly compared to an elephant's trunk, and with this they are able to draw up their delightful nourishment from the natural founts thus created for them deep within the calyx of the flower. Here, therefore, is another remarkable evidence of design, as well as of the singular adaptation between the animal and vegetable kingdoms, of which we shall treat more at large in the next chapter. We see in it, also, another proof that nothing is made in vain; but that, on the contrary, every created thing has its appointed end, and its use in the benevolent purposes of creative design. Amid such infinite profusion prevailing everywhere throughout the

natural world, we perceive the evidence of the inexhaustible powers of the Creator, and may thus, even from the weeds and minute insects which scarcely attract our notice as we pass them during the ramble of a summer day, form some feeble conception of "the fulness of Him who filleth all in all."

CHAPTER V.

ORGANIZATION OF PLANTS.

No study or education is needed to enable the eye to discern the delicacy and richness of colouring, or the beauty of form, of the full-blown rose, or to teach the olfactory nerve to appreciate its fragrant odour. The youngest child will show some sense of all these properties of the flower, and the illiterate cottar derives a pleasure from seeing it reared beside his clay-built dwelling. But here also there is room for higher sources of enjoyment to the cultivated mind. The flower may be dissected by the botanical anatomist, and will yield to him a thousand curious evidences of elaborate construction and profound design. The flower is no mere ornamental appendage to the plant, but is the evidence of its perfection and the source of its reproduction. Within the corolla, composed for the most part of a calyx or flower-cup, consisting either of a group of petals, or a single bell-like cup, are the delicate organs of fructification, on which the continuation of the species depends. The investigation of these furnishes the botanist with the chief basis of his science, and the diversified forms and arrangements on which his whole system of classification depends. The germ or vital point which contains the embryo seed and plant is contained in an inclosing member styled the ovary or seed-vessel. From

this rises a delicate stem called the style, supporting the *stigma* on its summit, and the whole together forming what is termed the *carpel*. Surrounding this complex member, but also within the *corolla*, or coloured part of the flower, are the *stamens*, consisting of slender filaments, supporting on the top the *anther*, which contains a yellow powder, the *pollen*, or fertilizing dust. In some flowers, there is only a single stamen. In others there are twelve of them. When the flower is fully ripe, the little bags or cases of the anther bursts, and the flower as it shakes in the breeze, sheds its pollen upon the stigma. On this simple process, the fructification of the flower depends, and this having been accomplished, it has answered its end, and immediately begins to wither. The ovary then expands, and becomes more fully developed, along with its inclosing seed, and this it is which, under artificial cultivation, is nurtured into fine edible fruit, such as the pear, peach, apricot, plum, &c., all of which, in their natural state, are little more fleshy than the wild crab or sloe.

On investigating the properties of all the various members which compose the flower, and endeavouring to discover the physiological use of each, our admiration is excited anew by the evidences which they disclose to us of elaborate and perfect design. The petals of the flower have been styled the lungs, supplying to the fructifying part functions analogous to those of the lungs in animals, and nearly similar to what is furnished to the rest of the plant by the leaves. The petals abound in air vessels, by means of which carbonic acid gas is formed; and, in addition to this process, it is decomposed by the proper leaves of the plant. But another and essential use of the corolla will be at once obvious to the most superficial observer, who has been informed of the use of the carpel and stamens, and of the functions they are destined to perform in impregnating and fructifying the ovary. This use is the protection of these organs of fructification, until their end

has been accomplished; for which essential purpose it is most obviously designed, and the numerous varieties of form which the corolla assumes, will always be found to be accompanied with some peculiar adaptation to the organic structure and functions of the plant. In the numerous class composed of four, five, or more petals, we have already alluded to the remarkable phenomena of many of them expanding their leaves, and turning to follow the sun, and again closing their petals when he sets, or when the sky becomes overcast and threatens rain. So remarkably sensitive are they in this respect, that even during an annular eclipse, they have been repeatedly observed to close their leaves, and open them again when the obscuration ceased. With the bell flowers again, where the flower is completed in one piece, as in the common blue-bell, or in the beautiful fox-glove, it is suspended so as to escape the rain. The multitude of flowers, also, which are so delicately supported as to wave in the wind, have by this means an additional protection against both wind and rain, turning away the delicate anther, with its store of pollen, which would be wasted and destroyed by the rude blast or shower. These and many other provisions of nature present themselves to the eye of the intelligent observer, in the wild weeds scattered around his path. It is in the natural wild flowers, indeed, and not in the forced productions of the garden and hothouse, that such exquisite provisions of nature must be sought for. To the intelligent eye, the meanest of those plants to which the contemptuous name of weed is applied, furnishes an object of study worthy of engaging all the powers of a well-informed mind in the investigation. They are the great link between animals and inorganic matter, forming not only an intermediate form of being, but being the indispensable connection between the two. We have spoken of the leaves and petals of plants as their lungs; by these they are continually inhaling and

giving out certain gases, while the lungs of animals exhale and inhale others totally different from these; and by means of the two, a continual compensating process goes on, by which the atmosphere is preserved in the state requisite for both. Plants during the day, and especially under the stimulus of strong light and sunshine, absorb carbonic acid from the atmosphere, and give out oxygen, while during the night they exhale carbonic acid, and hence it is that the growth of plants in the chamber where we sleep, is deleterious, the atmosphere of a close chamber being, by such vegetable exhalation, rendered unwholesome, and even poisonous. Animals, on the contrary, continually inhale oxygen, and give out carbonic acid; and hence the animal lungs are constantly restoring to the air what the vegetable withdraws from it, and the plant during the day gives out the essential oxygen or vital air, without which we cannot live many seconds.

The science of chemistry is quite of modern growth, yet in the great laboratory of nature by just such apparently simple means as this, the whole provision for the sustentation of animal life has been elaborated from the mineral kingdom and from the atmosphere. We have already described some of the chief vital processes of plants. By their roots, they take up from the soil, water, ammonia, potash, soda, lime, silex, sulphur, &c., and these, along with the carbonic acid gas and watery vapour which they absorb from the atmosphere, constitute what may be styled their proper food. With the single exception of the water, there is nothing in all these capable of being received into the body or made to contribute to the sustentation of animal life. Yet it is solely by the processes of vegetation that such inorganic matter is converted into food fit for animals. By chemical and vital processes within the cells of the plant, these substances are converted into starch, sugar, gluten, oils, gums, or resins, and woody fibre. The herbivorous animal directly partakes of this

vegetable preparation; the carnivorous animal, by an indirect process, no less entirely depends on the same; and thus do the wisdom and comprehensiveness of the designs of creation begin to become manifest as we pursue our investigations into the works of nature. Link by link each becomes revealed to us, and at length we perceive that the whole is bound together like the parts of one mighty chain.

In cryptogamic plants, such as ferns, mosses, lichens, and algæ, which belong neither to the exogenous, nor the endogenous class, there is no apparent proper flower. A minute germ, or *spore* is produced instead, sometimes in little cups, as in the mosses, or on the back of the leaf, as in ferns. This germ is the seed of the plant, which drops on the ground, and springs up anew, similar in growth to the parent. The stamens of the proper flowers, surmounted with their anthers full of pollen, and the carpel, are styled the male and female organs of the flower; their union being indispensable to its fertility. But all flowers are not furnished both with stamens and pistils together. In certain classes of plants there are males and females, entirely distinct, so that unless by some agency the pollen be brought from the anther of the male to the pistil of the female, they will remain barren, but all such necessities are provided for in nature. Bees and other insects, while in search of honey or sap from the flowers, are frequently the agents by which the necessary connexion is brought about; the pollen adhering to their body as they enter the flower, and then being communicated to the other when they alight on it in search of their food. The arrangement of these parts of the single flower is also no less apparent as a means for securing the needful fertilizing influence; and many of these are so varied and ingenious, as largely to reward the student of nature who seeks in them for fresh discoveries of a divine agency in the work of creation. But, indeed, we find

proof enough of this in a single stalk of grass. It is a hollow stem or tube, in which the problem seems to be wrought out, of making, with the smallest quantity of the simplest materials, a column of the greatest proportionate strength. It most frequently consists in its solidest parts of a thin layer of silex occupying the surface of the cylinder. This is the same mode of disposing of the material employed which we see in the bones of birds, where lightness and strength are equally requisite. The evidence of design which such a mode of construction affords, has long been felt by intelligent minds. It is told of the great Galileo, who had been accused of infidelity, because he called in question the false astronomical dogmas of an ignorant age, that when questioned by the Inquisition as to his belief in the Supreme Being, he pointed to a straw lying on the floor of his dungeon as the best answer to his accusers; saying to them, that from the structure even of that trifling object, he would infer with certainty the existence of an intelligent Creator. It seems, indeed, a strange thing to imagine, that thus surrounded as we are with the tokens of His presence and power, in whom we live, and move, and have our being, such a thing should be conceivable as the existence of an infidel; yet such a being has existed, blind to all the evidence around him, and choosing rather to trust to his own proud heart, and vain and corrupt will, than to listen either to the lessons of nature or the teaching of revelation. With such men, blinded in their own conceit, all argument is as vain as to insist on the power of harmony to the deaf, or the beauty of colour and proportion to the blind.

The universal appreciation of the beauty of flowers, and of the high ideal of the creative wisdom and love in which they have originated, is proved by the endless variety of treatment which their charms have suggested to the poetic fancy. The daisy, "wee, modest, crimson tippet flower," has excited the rapturous song of hundreds

of poets, and the sweet scented violet has scarcely less frequently charmed the fancy, and suggested the ideal of modest worth:

> "Half hid from human eye;
> Clear as a star, when only one
> Is shining in the sky."

The primrose, the blue-bell, the fox-glove, even the thistle and broom, have each found admirers, and excited the poetic fancy, and the devout aspiration. Enough has probably been said in this chapter, to tempt the young student to a fresh investigation of the beauties of all, and of the wonderful provisions for all the varied functions of vegetable life which each discloses.

CHAPTER VI.

MICROSCOPIC ORGANIC STRUCTURE.

WE are naturally led from the consideration of the various parts and vital functions of plants to an investigation of the more complicated structure of animals, and the nature of that higher form of life, of which we ourselves partake. Beautiful as the whole vital system of the vegetable kingdom appears, the functions of animated nature are still more remarkable. Animals have not only organs for nourishment, growth, and reproduction, but also organs of sense and motion, the faculty of volition, and all the powers of sentient enjoyment, as well as the capacity of suffering, and the accompanying sense of danger, which belong to their higher life. Viewing the vegetable and animal organizations merely as machines, we discover not only the more perfect and elaborate mechanism of the latter, but also its possession of certain characteristics which remove it beyond the category of

any known or conceivable piece of machinery of human device or construction. The involuntary motions and vital actions of the animal body are no less wonderful than any of those which we have noticed as pertaining to the vegetable kingdom; while in addition to these, this wonderful piece of mechanism possesses within itself its own power and volition; controls its own actions; supplies its own waste; selects for itself from among many objects the nutriment which it prefers; repairs or renews, and artificially aids and adorns its own structure; generates its own heat; regulates its motions; and reproduces new forms which grow to be structures like itself. The consideration of the animal frame under this idea of a mere machine, is of itself sufficient to excite in us the utmost wonder and admiration. Yet the points of resemblance and of contrast between the animal and vegetable kingdoms, equally suffice to illustrate the wisdom of creative design, and the wonderful adaptation of each subdivision of living nature to the sphere for which it was designed: "There is," says Kirby, "a singular contrast and contrariety between the majority of animals and vegetables. The head of the animal and the root or base of the vegetable perform the same office, that of collecting and absorbing the nutriment of each. The animal derives this nutriment from *organic* matter, the vegetable from *inorganic.* The plant gives oxygen to the heaven, and falling leaves and other matters to the earth. The animal gives nitrogen to the former, and the rejectamenta of its food to the latter. The most beautiful and admired, and odorous and elevated parts of the plant are its reproductive organs and their appendages, while in the animal they are the very reverse of this.

"But, in all this, we see the wisdom and forethought of the Creator. We see how exactly, by this mutual inversion, each class of beings is fitted for its station and functions. The plant to take root in, invest and ornament

the earth, and keep the atmosphere pure by a constant supply of vital air; the animal to browse and trim the vegetable, and by checking its luxuriance promote its welfare, to furnish it with a product calculated for its health and necessary to its existence; and by the manure, various in kind as the animals themselves, which it produces, supplying to the earth fresh pabulum for its vegetable tribes, and making good what it lost by the exhaustion, occasioned by the infinite myriads that, investing it on all sides like a garment, derive their nutriment from it, some plunging deep, and others, as it were, skimming the surface: if we contrast this with the returns they make, we shall be convinced that, in this case, the expenditure would vastly exceed the income, and that a class of beings was essentially necessary as a counterpoise, which, by taking little or nothing immediately from the soil, at the same time that they added to it, some in a greater and some in a less degree, might afford a sufficient supply of those principles which are indispensably requisite for the due nutriment and development of the various members of the vegetable kingdom, and thus maintain an equilibrium, and make good the deficiency just stated."*

The remarkable contrast which we thus perceive to exist between the animal and vegetable kingdoms, seems to place the two so completely apart as to render the possibility of any confusion or difficulty in marking the precise line of demarcation between them scarcely conceivable. No two things possessing life can well differ, to all appearance, more completely in every essential attribute than an oak and a horse, or a palm-tree and a lion; yet the affinities discoverable in the structure of all organic bodies approach almost to a coincidence at the extremes of animal and vegetable life, and it is in reality scarcely possible to define the precise characteristic which

* Kirby's Bridgewater Treatise, vol. i. p. 139.

shall determine whether certain living things shall be regarded as animals or vegetables.

The investigation which we are now pursuing into the various characteristic phenomena, which accompany the progress of the seasons, will receive considerable elucidation, if, in following up the inquiry suggested to us in the present section, we devote some little space to the consideration of those lowest forms of organized existence; the fungi and animalcules, which seem to stand at the very foot of the scale of being, and to mark a limit below which it is impossible to go without passing into the inorganic kingdoms. Animal and vegetable being, commences alike in forms so minute, as to be invisible to the naked eye, and with organic structures at once so simple and so nearly alike, as to suggest the probability of their partaking of the two natures. The *protophyta* or *first-plants*, and *protozoa* or *first-animals*, as they have been denominated, possess so much in common, that it has appeared probable to some scientific observers, that they are either animal at one period of their existence, and vegetable at another, or else are partly animal and partly vegetable,—a thing seemingly inconceivable and absurd, if we think of it with reference to the higher orders of organized beings, as that a living creature should be partly an ox and partly an oak! It is certain, however, that among these *protophyta*, a class of plants has been observed, which have a power of oscillatory movement, connecting them apparently with the animal kingdom: the power of voluntary motion, and of a change of place being one of the assumed characteristics, essentially distinguishing animal from vegetable life. "When collected in masses these *oscillatoriæ* resemble a piece of green velvet. Some cover considerable spots in moist places; others live in the water, either fixed to substances contained in it, or floating on the surface. They are generally based on a mucilaginous substance, the remains of those

that, having fulfilled their functions, are become a caput mortuum. The filaments of which the living plant is composed continually oscillate from right to left, or from left to right, but very irregularly, some going in one direction, others in another; some remaining stationary while others continue in motion.

"Professor Agardh inclines to the opinion that these oscillating plants owe their existence to different species of *animalcules*, which at first swim about as animals, and afterwards fix themselves as plants. This opinion has been adopted by others; and lately Mr. Unger has stated that he has seen animated particles separate from the parent plant, in a few hours converted into globules of vegetable matter, which subsequently became plants perfectly similar to the individual from which they were produced." *

The movements, however, observed in these oscillatoriœ, are not of such a kind as necessarily to partake of the true character of voluntary motion, but may be merely mechanical, like many of the contrivances by which the seeds of some plants are forcibly ejected from their ovaries; or others, such as the dandelion, which are winged, and so are enabled to fly to a considerable distance. It is, at any rate, a sound principle in inductive philosophy, that all safe theories must be based on well ascertained, and not on doubtful or hypothetical evidence. But quitting this uncertain field, we find a class of beings pertaining to the animal kingdom, yet belonging to that place at the very bottom of the scale, where the resemblance approaches nearly to a precise correspondence with certain equally low forms of vegetable life. The *infusories* are so called because they can be produced at any time by means of infusions, the ova, seeds, or eggs, being, as may be supposed, constantly present in the air, or in contact with certain substances, and only requiring the

* Kirby's Bridgewater Treatise, vol. i. p. 146.

requisite conditions of life, to be animated, and fulfil all the functions of their being. An infusion of hay, for example, made in summer, in a little spring water, or of a sprig of mignonette, or a tuft of hemlock blossom, or a little vinegar, allowed to stand exposed for a time, will, after a few days, exhibit a filmy scum on the top, and on examining this through a microscope, it is found to consist of numerous animalcules, moving about, and exhibiting all the evidences of animal life peculiar to their position in the scale of being. "These wonderful little creatures," says Kirby, "though they are everywhere dispersed, remain like seeds, without apparent life or motion, perhaps after animation has been suspended for years, till they come in contact with some fluid, when they are immediately reanimated, move about in various directions, absorb their proper nutriment, and exercise their reproductive powers according to the law of their several natures. Yet these little animals, though in some respects they exhibit no slight analogy to vegetables, are not only distinguished from them by their irritability, but likewise by their organization, and powers of locomotion and voluntary action. Their mode of reproduction, however, is not far removed from that of some vegetables; they are spontaneously divisible, some longitudinally and others transversely, and these cuttings, if they may be so called, as in the hydra or common polype, become separate animals. They are also propagated by germes, and some appear to be viviparous. The species of *vibrio* found in diseased wheat by M. Bauer is oviparous, as is evident from his observations and admirable figures. Lamarck indeed regards them as having no volition, as taking their food by absorption like plants; as being without any mouth, or internal organ; in a word, as transparent gelatinous masses, whose motions are determined not by their will, but by the action of the medium in which they move. That they have neither head, eyes, muscles, vessels,

nerves, nor indeed any particular determinable organ, whether for respiration, generation, or even digestion. On account of these supposed negative characters, they were called by De Blainville, *Agastria*, or stomachless, as having no intestines; but Ehrenberg, who has studied them in almost every climate, has discovered, by keeping them in coloured waters, that they are not the simple animals that Lamarck and others supposed, and that almost all have a mouth and digestive organs, and that numbers of them have many stomachs. Spallanzani, and other writers that preceded Lamarck, had observed that their motions evidently indicated *volition:* this appeared from their avoiding each other and obstacles in their way; from their changing their direction and going faster or slower as occasion required; from their passing suddenly from a state of rest to motion without any external impulse; from their darting eagerly at particles of infused substances; from their incessantly revolving on themselves without a change of place; from their course against the current; and from their crowding to shallow places of the fluid in which they are: each species seems also to exhibit a peculiar kind of instinct. Lamarck thinks all this delusion, proceeding from errors in judgment, and the result of prejudices inducing people readily to believe what accords with their persuasions. But to apply this remark to such observers as Spallanzani, &c., is drawing rather largely on the credulity of his readers, who might very justly turn the tables and apply it to himself, who is certainly as much chained by system as any one can be. Admitting that the observations of Spallanzani just stated record facts, it appears clearly to follow from them that these animals *have* volition, and therefore cannot properly be denominated *apathetic*, or insensible. The fact that they almost all have a mouth and a digestive system; many of them eyes, and some rudiments of a nervous one, implies a degree, more or less,

of sensation in them all, and consequently that they have all, whether it be molecular and diffused in their substance, or confined to particular organs, I say that they have all a nervous influence and excitement sufficient for their several wants, corresponding with their several natures." *

Minute as these simple forms of being are, they present an almost endless variety of form and structure. Most of our readers have probably seen the wonderful disclosures which are exhibited, when a drop of water is exposed under the magnifying powers of a solar microscope. The amazing variety of strange and monstrous forms revealed by such means, the singular actions and the varied modes of progression, as well as the curious transformations which they undergo, may suffice to convey some idea of the inexhaustible energies of creative power. Some are circular, elliptical, or triangular, others resemble dragons, serpents, or eels; several have horns or feelers, and others long tails; while many more present shapes altogether unknown before in connection with any development of organic life; funnel or bell-shaped, reticulated orbs, or angular bodies connected by long and scarcely visible threads. Their motions and actions are no less strange and diversified, so that the microscope opens up to us a world in some respects even more wonderful than that which the telescope discloses. Nor are we able to fathom the one, and exhaust its mysteries any more than the other; for it is considered that many of the microscopic infusoria, such as the wheel-animalcules are predaceous, and live on beings still more minute than themselves, so truly is it demanded of us: Who by searching can find out God? The immense telescope of Lord Rosse has resolved many nebulous masses into multitudes of stars, and revealed millions more altogether invisible to the naked eye; but it also brings into view other nebulae beyond these which it cannot resolve; and for all the

* Kirby's Bridgewater Treatise, vol. i. p. 149.

additions it has made to our knowledge, leaves the boundlessness of the unknown universe greater than before. Even so it is with the microscope. We wait for the discovery of still higher magnifying powers to add to our knowledge of the animalculæ which abound in countless millions within the drops of dew, and the little pools of water, but we have no ground for assuming that with these we shall reach the limits of microscopic being.

These invisible animalcules may be literally said to be universally present, and to be infinite in numbers according to our means of enumeration. They inhabit the sea, the rivers, lakes, and other waters. Hundreds of thousands are present in a single drop of water, so that the attempt to compute the numbers even occupying some little pool, would altogether surpass the powers of human calculation. But, indeed, it may be asked where these microscopic living creatures are not present? They are found in the blood and saliva of man and other animals, in the tartar which accumulates on our teeth, in all animal and vegetable substances; in fruits, seeds, and grain; and in vinegar, which would be destructive to other forms of being. Life indeed appears to be universally present; and if we can only conceive, however dimly, of such a universe, and think of all this as created and sustained by the one Supreme Ruler, we shall perhaps arrive at some devout and humble conception of the infinite greatness of the Divine Being, in whom all things live and have being.

It is among these animalcules that we find the singular beings which Humboldt has proposed to form into a subkingdom, which he denominates *Phyto-zoa*, or plant-animals. In many of these a small bag or little mass of jelly, containing a single cavity or stomach, constitutes an animal, and a few cells joined together form a plant, each in their simplest forms very nearly resembling the other. The *Lemna gibba*, for example, or duck-weed,

seen so frequently, in green seed-like clusters, floating on the surface of fresh water, consists of a cellular body or frond, with rootlets and spongioles. The *Cysticercus cellulosa,* or Hydatid, again, is an animal consisting simply of a sack or stomach,—in form closely resembling the cellular body of the former,—with a long neck and mouth, to which are attached two hooks by means of which it adheres to the soft part of larger animals. But a more curious class, forms one of the two divisions of Humboldt's sub-kingdom, that is, of the polygastric or many-stomached anamalcules. These appear to recede the furthest from the organization of the higher forms of animal life, and more nearly to approach that of vegetables; and it is unquestionable that the precise line of demarcation between the one and the other cannot be drawn. The *hydra*, or fresh-water polype, for example, found attached to leaves and reeds in slow running streams, rather resembles a parasitic plant than an animal, though classed with those pertaining to the latter kingdom. It has a small jelly-like body, with a mouth surrounded by seven or eight arms or *tentacula*, with which it seizes its food. The inexperienced observer, on viewing it as seen under a strong magnifying glass, so as to show its precise form, would assign it without hesitation to the vegetable kingdom. It may be described as most nearly resembling a star-fish growing on the top of a stalk, and is therefore not unlike many of the astral flowers. But the most curious feature is, that these hydræ propagate their young by shooting out slips or buds from the parent body, so that they present, when thus reproducing their species, the appearance of a fully developed flower, with a young bud just about to bloom. Their essential characteristic of animal life, however, is that they receive their nourishment by the head and mouth, and not by the root. They may also be cut into pieces, and each portion, like the slips of certain plants, will grow into a distinct being.

They are also capable of motion. Though they usually remain fixed to one spot, and only move their arms, yet when the want of light or heat renders a change of locality desirable, they move by fixing alternately their head and tail to the surface, much in the same way that a leech may be seen to do.

The invention of the microscope has drawn aside the veil which hid from us this wonderful world of being. It is but a few years since the fact has been revealed to us that we are thus surrounded by an infinity of life and sentient enjoyment. Yet the same microscope shows that the chalk, and certain masses of rock, are composed of an infinite congeries of the shells or other debris of extinct animalcules; so that not only has this infinitude of microscopic life surrounded man unconsciously, through the whole period of his existence, but thousands, and probably millions, of years before his race was called into being, they were rejoicing on our earth, in the full exercise of all their faculties of living existence. Vegetation is no less minute. The blue mould on old bread appears, when seen through the microscope, to consist of a number of mushroom-like stalks, with a round seed-bag on the top of each; and even many cutaneous diseases are now found to consist in certain vegetable growths on the skin. So also the mould which is frequently found within the core of an apple or pear, or which grows on it when kept till it has begun to wither and decay, is found to be a moss-like plant, with seed vessels on the top, by which it is propagated like any other vegetable.

"Everybody who has eyes is aware that vegetation takes place upon almost every substance; upon the bark of trees, upon naked rocks, upon brick walls and tiled roofs, and even upon glass when not constantly cleaned. The first plants that take on these their station, usually look like green or yellow powder, when they decay forming a little soil, in which others more conspi-

cuous find sufficient nutriment, and so one succeeds another till a sufficient portion of soil covers the rock, &c., to afford the means of life and growth to more perfect plants, and often to arborescent ones. An analogous process takes place in the water. The *matière verte* of French authors makes its appearance, and other Hydrophytes, in conjunction with the Infusories, form as it were a first soil for the support and maintenance of animal life, both for those which derive their nutriment from vegetables, and those that feed on beings of their own class. Thus a maintenance is provided for higher forms, and, at last, for the highest; and a table is spread, both on the earth and in the waters, for every living thing, from that which the eye cannot discover, to man, the head and king of all.

"How wonderful and adorable is that Almighty Being, who thus made all things dependent upon each other, and based the visible world, in the three great departments into which we see it divided, upon an invisible basis, and in which cohesion and life are maintained by those powers which God has placed as rulers in the physical world, and by which He still acts upon the universe of existences."*

CHAPTER VII.

INSECT METAMORPHOSES.

In treating of the changes and developments peculiar to spring, some of the remarkable phenomena displayed in the development of insect life have been referred to. The most remarkable of these, however, belong to the genial season of summer, when the warmth of the air invigorates the whole insect kingdom, and the air is filled with the

* Kirby's Bridgewater Treatise, p. 162.

hum of millions of insect wings. It is not purposed here to attempt a systematic account of the varied transformations which insects undergo even under our own temperate skies. The subject is one which a volume could not exhaust, and can therefore only be glanced at in a few of its more striking illustrations in our limited space. Among the delightful series of volumes of the Library of Entertaining Knowledge, one is devoted to this subject of Insect Transformations, and a more attractive volume for the study of the young naturalist could scarcely be conceived. He may there perceive that no fairy tale, or fiction of the Arabian Night's Entertainments, can compare in wonder with the actual truths of daily occurrence around him. It is told by Boerhaave, that when the Grand Duke of Tuscany visited the great philosopher Swammerdam, in 1668, he was so astonished by the wonders of the insect world which he disclosed to him during a single interview, that he made him a princely offer to induce him to take up his abode at his court. Yet the wonders of nature which so delighted the Italian Duke, are within reach of all, and may be studied with extremely little trouble. It seems an extravagant and marvellous idea that plant-animals should exist, or any form of organic life partaking both of the properties of the animal and vegetable kingdom. Yet this is little more marvellous than that eggs should be laid on the water, produce aquatic grubs, which find there their natural element, and yet that from such should be produced a fly whose proper element is the air, and which would immediately perish if replaced in the water from which it has just emerged!

One of the curious processes which may be observed in spring is the construction of the little boat-shaped raft of its eggs, which the gnat commits to the water. Each is heavy enough to drop at once to the bottom if placed there singly, yet she ingeniously arranges the whole,

consisting generally of about three hundred eggs, in the shape of a broad flattish canoe, which floats securely on the water, and there it is abandoned by the mother gnat. So admirable is the construction of this delicate boat that it continues safe, and without any wet lodging on its surface, during the most violent agitation of the water. The eggs are hatched there in a few days, and the grubs, which may be met with in abundance, in almost any ditch, during the summer, present a most singular structure adapting them to their watery element. They are, of course, extremely minute, as may be supposed from the size of the parent fly; but when examined through a microscope, their remarkable respiratory apparatus, provided for this mere transitional and temporary stage of being, appears altogether marvellous. "The organs for breathing, which are very remarkable in the grub of the gnat, are not situated along the sides, as in caterpillars, but in the tail. A tube for the purpose of respiration goes off from the terminal ring of the body at an angle. Its main buoys, also, are its tail and its breathing tube, both of which end in a sort of funnel composed of hairs, in form of a star, anointed with oil, so as to repel water. Swammerdam remarks that when, by handling it too roughly, this oil is removed, the grub 'can no longer suspend itself on the surface of the water, I have, on these occasions, observed it put its tail in its mouth, and afterwards draw it back, as a water-fowl will draw its feathers through its bill to prepare them for resisting water.' The air, which enters through several openings in the breathing-tube, passes onwards to two lateral windpipes, very similar to those of caterpillars, as above described. When it wishes to descend to the bottom of the water, it folds up the hairs of the funnel, but by means of its oil, retains at their ends a globule of air; and when it wishes to re-ascend, it has only to open its hair funnel again.

"A similar but more elegant apparatus for the same purpose occurs in the water-grub of a two-winged fly, which Goedart called the chameleon fly (*Stratiomys chameleon*, Meigen), because he found it could live nine months without food. The terminal ring of this grub is extended to a considerable length, and fringed at the end with a beautiful star-like funnel of thirty feathered hairs. Whether the creature oils these, like the grub of the gnat, we know not, but they perfectly repel water; and at the point where the insect hangs suspended, a small dimple may be observed on the surface. When it wishes to dive to the bottom, it has the power of bringing the ends of the hairs together, without diminishing the capacity of the funnel below; and a globule of air, for the purpose of breathing under water, is thus inclosed and carried down, appearing, as Swammerdam says, like a brilliant pearl or polished silver. 'As for my part,' he adds, 'I dare boldly affirm, that the incomprehensible greatness of the Deity manifests itself in these mysterious operations in a particular manner, and affords us an opportunity of examining, as it were, with our senses, the divine nature.'"*

Similar remarkable arrangements of apparatus occur in the larva of many insects which live during their first stages in the water. All evince the same wondrous adaptation of means to an end, and show how inexhaustible are the powers of the Creator in providing for every necessity of the minutest of his creatures. Yet the transition to the perfect and final state of their being is no less remarkable, when all this singular apparatus is laid aside, as a thing which has fully answered the end for which it was designed. "About eight or ten days after the larva of a gnat is transformed into a pupa, it prepares, generally towards noon, for emerging into the air,

* Insect Transformations, p. 155.

raising itself up to the surface so as to elevate its shoulders just above the level of the water. It has scarcely got into this position for an instant, when, by swelling the part of its body above water, the skin cracks between the two breathing tubes, and immediately the head of the gnat makes its appearance through the rent. The shoulders instantly follow, enlarging the breach so as to render the extrication of the body comparatively easy. The most important, and indeed indispensable part of the mechanism, is the maintaining of its upright position so as not to get wetted, which would spoil its wings and prevent it from flying. Its chief support is the rugosity of the envelope which it is throwing off, and which now serves it as a life-boat till it gets its wings set at liberty and trimmed for flight. The body of the insect serves this little boat for a mast, which is raised in a manner similar to movable masts in lighters constructed for passing under a bridge, with this difference, that the gnat raises its body in an upright direction from the first. 'When the naturalist,' says Réaumur, 'observes how deep the prow of the tiny boat dips into the water, he becomes anxious for the fate of the little mariner, particularly if a breeze ripples the surface, for the least agitation of the air will waft it rapidly along, since its body performs the duty of a sail as well as of a mast: but as it bears a much greater proportion to the little bark than the largest sail does to a ship, it appears in great danger of being upset; and once laid on its side, all is over. I have sometimes seen the surface of the water covered with the bodies of gnats which had perished in this way; but for the most part all terminates favourably, and the danger is instantly over.' When the gnat has extricated itself all but the tail, it first stretches out its two fore-legs, and then the middle pair, bending them down to feel for the water, upon which it is able to walk as upon dry land, the only aquatic faculty which it retains after

having winged its way above the element where it spent the first stages of its existence."*

Similar processes of emergence from the intermediate aquatic stage of being to the state of a perfect fly, may be observed in many other insects, though each with some feature peculiar to itself, and connected more or less with some special habit of the insect. We shall turn now, however, from these to the more familiar, but no less remarkable phenomena which are observed in the transition from the caterpillar to the chrysalis and the butterfly. These changes have appeared so remarkably to illustrate the ideal of that most marvellous of all changes which revelation has alone surely revealed to us—the passage from death to life, and the eternal existence of the human soul—that the butterfly was employed by the Greek poets and artists as the emblem of the soul, and is still familiar to us as the symbol of the same idea.

The old classic poets delighted in recording and inventing certain marvellous fables, chiefly in reference to the gods of their own pagan creed; but all depending for their interest on the marvellous transformations undergone, and which accordingly are styled *metamorphoses.* Yet these inventions of poetic fancy appear tame and commonplace, when compared with the singular changes which accompany the development of insect life. When we see, indeed, the form of an insect egg, and of the crawling grub which it produces, it would seem to require a wondrous series of metamorphoses to change either into the beautiful butterfly. Yet, though the various preparatory changes are sufficiently marvellous, they appear after all, rather a succession of leaps towards perfection, than the slow and tedious process which would seem needful for so great a change. Meanwhile, however, it is interesting to observe, amid all the infinite variety of changes undergone in the annual development of insect

* Insect Transformations, p. 317

life, how uniform are the great laws to which all appear to be subjected. No insect comes forth from the egg in a perfect state, nor is any one provided with wings in the earlier stages of being. The winged state is invariably the highest and final one; and that in which the purposes of reproduction for the continuance of the species, are alone seen in operation. But in the endurance of the winged state, all resemblance to the ideal of the winged and emancipated soul is at an end. The insect state of perfection is altogether a transient one; the gay and beautiful butterfly, having attained to its full maturity, flits about in the sunshine for a few days, or sometimes only for a few brief hours, and then the end of its being is accomplished, and it perishes; giving way to other generations of its own beautiful, but transient race.

We shall now glance at the successive stages of the metamorphoses of the *Lepidopterons*, or butterfly and moth tribe, and at the various remarkable phenomena which accompany such changes. In them we have a series of changes wherein scarcely the slightest resemblance can be traced between the one and the other, in so much so that, but for our familiarity with the progress of lepidopteral development, we could scarcely be more astonished were the egg of a fowl to give birth to a serpent, and that, after changing into a dry and shrivelled mummy, were suddenly to burst, and expose to view a bird fully fledged, and resplendent with the most gorgeous plumage. Yet metamorphoses closely resembling these are constantly taking place among the insect tribe throughout the whole summer season. Taking the silk-worm as a familiar example, on many accounts peculiarly fitted to furnish for us the minute illustrations which we desire: there is first the egg, a mere speck, as seen by the naked eye. This in due time gives birth to the caterpillar, a long worm, in which we look in vain for any indications of its future winged state; though naturalists find on

microscopic investigation, that the rudiments of all the organs of the perfect insect are in reality contained within the full grown caterpillar.

Some conception of this appears to have always been entertained, as is implied by the term *larva*, applied to the insect caterpillar or grub, the name being the Latin one for a mask, and implying that under its lowly form are concealed the full beauties of the perfect insect. Externally, however, no indications of the inclosed rudiments of future perfection appear, the caterpillar is found to present an elongated annular structure, having short feet, with claws or hair-bristles, for facilitating its movements. The economic value of this caterpillar has, ot course, led to a degree of attention to the various details of its progressive development, not devoted to any other varieties of the tribe. The progress of the caterpillar both in size and weight seems altogether marvellous, when compared with the slow growth of even the most rapidly developed animals; and their voracity is proportionally great, so that the immense amount of mischief sometimes effected by caterpillars may be readily understood. A single caterpillar of the silk-worm, weighing when first hatched only the hundredth part of a grain, will consume in thirty days an amount of mulberry leaves forming altogether a quantity of vegetable matter exceeding by about 60,000 times its own original weight. Its growth, however, is proportionate to its rapacity. In twenty-eight days it increases in length by about forty times its original dimensions; and exceeds by nine hundred and fifty times its original weight. During this progressive increase, the caterpillar four times changes its skin; each time securing itself, by a silken thread which it spins, to the place where it happens to be at the time, so as to preserve it from falling, or being blown away while casting its skin. Before the fourth change takes place it has attained its full growth, and it then ceases to eat. About

ten days after this it carefully seeks out for a safe retreat where it may begin the weaving of its silken shroud. The spinning of a silken cocoon is by no means peculiar to the caterpillar of the *Bombyx mori*, or the silk-worm, as it is called, *par excellence*. But the superiority of its silk, both in quantity and quality, has led to its selection for providing the finely spun insect thread in such extensive use throughout the civilized world. The silk bags are long slender intestinal vessels, within which are secreted a liquid gum. These bags are closed towards the tail, and expand as they recede from it, until they approach towards the head, where they contract, and form the spinning-tube, or spinneret. Under the mouth of the silk-worm is a plate perforated with two holes, which unite, and are capable of expansion or contraction, so as to regulate the thickness of the thread. The caterpillar ejects through these holes two drops of gum, which it fixes to some point, and then draws back its head, or lets itself drop, suspended by the threads, which are immediately formed and continue to lengthen so long as it chooses to continue the operation of spinning. This fine natural apparatus has been compared with that of the gold-wire-drawers, but the most ingeniously devised machines of human invention appear rude and imperfect, when compared with the wonderful provisions which the Creator has lavished on the meanest of his creatures. The caterpillar of the common cabbage butterfly, has its complete spinning apparatus, and employs it during its larva state, as well as in providing the silken shroud within which it passes into the next state of being. It uses the fine silken threads especially for assisting it in its progress over smooth surfaces, and will by this means climb up a pane of glass, spinning across it a zigzag line of thread which serves as a sort of rope ladder up which it ascends. It also lets itself down by the same means from the branch of a tree to the ground; descending through the air as a spider is seen to do, by

attaching its thread to the point from which it starts, and then spinning it out, until it has reached the lower level at which it aims.

When the silk-worm begins to weave its cocoon, it may be observed to attach its thread to some object near to where it stands. It then begins to spin very regularly, moving its head from side to side, and interweaving the threads around it, until it is at length entirely enveloped in the silk. The covering consists, when completed, of three different envelopes, the outer one of which is coarse, and serves to protect it from injury from rain. When this has been completed, the caterpillar is transformed, within its wonderful silken cell, into a chrysalis. In this state it needs no food, the requisite nourishment having been already stored up by the caterpillar, in the state of a yellowish mucus secreted in its stomach. In this state the rudiments of the perfect moth are gradually developed. The wings, the antennæ, and the legs, assume form and consistency, and at length the perfectly formed moth growing too large for the chrysalis case, it bursts, and frees it into the chamber of the cocoon, through which it eats its way, and escapes into the open air. This final process, however, is attended with radical injury to the silken coil, and is therefore prevented by the destruction of the inclosed insect, when its wonderfully wrought cocoon is desired for the use of man.

The outer covering is called the floss or loose silk, but it is the middle one that is of commercial value, and applied to use in the manufacture of silk webs. This can be unwound without breaking it, being composed entirely of one continuous thread, sometimes measuring a thousand feet in length. Yet so light is the fragile thread that it takes 10,000 cocoons to make five pounds weight of silk. It may be conceived from this what a number of the caterpillars must be annually bred and destroyed before they reach their perfect or moth state, in order to pro-

duce the enormous quantity of silk in use for manufactures throughout the world. The value of the manufactured silk consumed in this country alone, in a single year, is upwards of £6,000,000 sterling; while throughout the continent of Europe, as well as in that of Asia, in which the manufacture originated, it is used to a very great extent. The culture of silk as an article of commerce has been repeatedly tried in this country, but without success, though similar attempts have beeu amply rewarded in milder climates, as in Greece, Italy, Spain, and France, as well as in America. On the revocation of the edict of Nantes, many of the silk manufacturers and weavers of France who adhered to the Protestant faith, took refuge in this country, and gave a great stimulus to the manufacture of silk, as well as led to various attempts at rearing the worms. To this movement, originating in Romish persecution and bigotry, we owe the extensive and populous manufacturing district of Spittalfields, London, as well as the establishment of some of the most important branches of manufacture in Norwich and other towns. A street in the New Town of Edinburgh bears the name of Picardy Place, from its occupying the site of a village of the French refugees, who had conferred on it the name of the district of their native land from which they had been ejected. After their settlement in the vicinity of the Scottish capital, a neighbouring hill, now covered with streets and squares, was purchased, and planted with mulberry trees, for the purpose of feeding the silk-worms; but the climate, it may be presumed, proved equally unsuited to the trees and to the caterpillars they were intended to feed, and the plan had to be abandoned for some other scheme better suited to our inhospitable climate.

CHAPTER VIII.

THE ARACHNIDANS.

THE silk-worm is only one example of the wonderful provisions of nature for supplying the necessities, and providing for the reproduction of the species, in the insect kingdom. This curious manufacture of silk pertains to many insects in their earlier transitions, and also to nearly all the *arachnidans*, or spiders, which the naturalist does not reckon among true insects. Few living creatures fall under more general observation than the spiders. "We see them everywhere, fabricating their snares or lying in wait for their prey, in our houses, in the fields, on the trees, shrubs, flowers, grass, and in the earth; and, if we watch their proceedings, we may sometimes see them, without the aid of wings, ascend into the air, where, carried by their web as by an air-balloon, they can elevate themselves to a great height. The webs they spin and weave are also equally dispersed; they often fill the air, so as to be troublesome to us, and cover the earth. M. Mendo Trigozo relates, that at Lisbon, on the 6th of November 1811, the Tagus was covered, for more than half an hour, by these webs, and that innumerable spiders accompanied them, which swam on the surface of the water."* One of the uses of this numerous family undoubtedly is, by their predacious habits, to control the number of the flies, and prevent them becoming a plague by their excessive increase. This purpose they most abundantly effect, spreading their snares wherever the insect tenants of the air are to be found, and manifesting a mixture of skill, patience, and persevering ingenuity, to which it would be difficult to find a parallel in the whole animal kingdom. They appear, indeed, to set at defiance

* Kirby's Bridgewater Treatise, vol. ii. p. 283.

the ordinary limits of the insect family, and with a practical ingenuity which seems akin to the inventive mechanical skill of man, they surmount the barriers which shut in other insects to one element. Without wings, they are able to fly through the air, upborne on a silken balloon, woven by their own unaided art; and destitute, apparently, of all fitness for aquatic habits, they pursue their prey with equal skill and safety in the water, answering thus the same ends which they do on land, and in the air. "The insects that frequent the waters require predaceous animals to keep them within due limits, as well as those that inhabit the earth, and the water-spider is one of the most remarkable upon whom that office is devolved by her Creator. To this end her instinct instructs her to fabricate a kind of *diving-bell* in the bosom of that element. She usually selects still waters for this purpose. Her house is an oval cocoon, filled with air, and lined with silk, from which threads issue in every direction, and are fastened to the surrounding plants; in this cocoon, which is open below, she watches for her prey, and even appears to pass the winter, when she closes the opening. It is most commonly, yet not always, entirely under water; but its inhabitant has filled it with air for her respiration, which enables her to live in it. She conveys the air to it in the following manner: she usually swims upon her back, when her abdomen is enveloped in a bubble of air, and appears like a globe of quicksilver; with this she enters her cocoon, and displacing an equal mass of water, again ascends for a second lading, till she has sufficiently filled her house with it, so as to expel all the water. The males construct similar habitations by the same manœuvres. How these little animals can envelope their abdomen with an air-bubble, and retain it till they enter their cells, is still one of Nature's mysteries that have not been explained. We cannot help, however, admiring and adoring the wisdom, power, and goodness

manifested in this singular provision, enabling an animal that breathes the atmospheric air, to fill her house with it under the water; and which has instructed her in a secret art, by which she can clothe part of her body with air, as with a garment, which she can put off when it answers her purpose. This is a kind of attraction and repulsion that mocks all our inquiries."*

The fine silken thread with which the spider constructs its web is no less adapted for the purposes of the manufacturer than that which forms the cocoon of the silk worm, and repeated experiments have been made with a view to its application to economic uses. One ingenious experimenter carried his experiments so far as to complete a pair of spider-web gloves; and, satisfied by his success, of the perfect adaptability of the material to all the uses for which the thread of the silk-worm is used, he collected a number of spiders of the species which seemed to him best adapted for his purpose, and furnished them with all the facilities that could be artificially supplied, in order to encourage their labours. Here, however, he made known the impediment which must ever render fruitless all attempts at obtaining a sufficient supply of the spider silk to render it available for the loom. If thousands of the silk worm are assembled together, so long as they are supplied with a sufficiency of the lettuce, or mulberry leaf, for their enormous appetites, no greater difficulty is experienced than if only one is to be attended to. But no sooner were the flock of spiders brought together than all the useful labours of the spinners were abandoned, in order to give place to their irascible pugnacity. The instant two of them approached within sight of each other, a combat took place, and in a very short time, out of the whole number which had been collected, only one or two of the largest remained alive. It is curious thus to discover in predaceous insects, the same solitary habits as

* Kirby's Bridgewater Treatise, vol. ii. p. 296.

we have already observed to pertain to the largest carnivorous animals, doubtless given to them for the same ends. Without such spoilers, we have reason to believe that the insects on which they prey, would become altogether intolerable; but if they were not also thus solitary in their habits, and inimical to each other, they would eradicate the whole insect families on which they prey. Here, therefore, as in so many other instances, we see how remarkably an over-ruling providence is apparent even in the most mysterious departments of nature, controlling the whole for wise ends, and preserving amid conflicting elements, the balance of forces on which the stability and permanence of the whole depend.

The apparatus by which the spider is able to weave its ingenious web, is situated at the posterior extremity of the abdomen, on the lower side. Here a round depressed space may be observed, on which are four or six jointed teat-like organs, of a conical shape. Two of these are long finger-like projections, with three joints, while the smaller ones are perforated at their extremities, with innumerable little orifices, through which they are able at their will to issue the minute threads which, united together, form the lines of their webs. These are connected with the internal reservoirs in which the gum is secreted, which yields the fluid drawn out by them into these silken threads. The spider has these reservoirs and spinnerets completely under its control, so that they can furnish lines of various thickness, and produce, it is said, three different kinds of silk. So fine is the thread ordinarily drawn by the spider, that it is calculated to require twenty-four of them to make one equal in thickness to that of the silk-worm. The ingenious insect knows, however, how far to trust to this fragile line. Its web is constructed with the same skill which experience teaches the fisherman to apply in weaving his nets. The outer lines are multiplied so as to give strength and security to the whole.

The strong lines, or stays, stretch to the principal points of attachment, and only the fine transparent net-work of the centre is formed of the delicate single thread. Yet this possesses great strength compared with its apparent fragility. The spinner commits himself fearlessly to the line, which he continues to spin while suspended in air, and returns by it again to his perch; and so tenacious is it, that it will bear six times the weight of the spider, without giving way.

The spider employs its silken lines in various ways, according to the peculiar habits of the species, and the nature of the prey which it ensnares. One of the weaver spiders, which is chiefly found frequenting the cavities of walls and similar places, spins a web of varied texture, part of it having the appearance of flocky or ravelled silk. "This web is produced by a double series of spines, opposed to each other, and planted on a prominent ridge of the upper-side of the metatarsal joint, or that usually regarded as the first joint, of the foot of the posterior legs on the side next the abdomen. These spines are employed by the animal as a carding apparatus, the low series combing, as it were, or extracting, the ravelled web from the spinneret, and the upper series, by the insertion of its spines between those of the other, disengaging the web from them. By this curious operation, which it is not easy to describe clearly, the adhesive part of the snare is formed, thus large flies are easily caught and detained, which the animal, emerging from its concealment, soon despatches and devours.

"The organs by which the *retiary* spiders form their curious geometric snares, have generally been described as three claws, the two uppermost armed with parallel teeth like a comb, and the lower one simple and often depressed; but Mr. Blackwall found, in a species related to the common garden spider, *eight* claws, seven of which had their lower side toothed. The object of this complex

apparatus of claws simple and pectinated, is to enable these animals to take hold of any thread; to guide it; to pull it; to draw it out; to ascertain the nature of anything ensnared, whether it be animate or inanimate; and to suspend itself. In fact, the Creator has made their claws not only hands but eyes to these animals.

"Besides these organs, scattered moveable spines or spurs are observable upon the legs, especially the *three* last joints, which I consider as forming the foot, but sometimes also upon the thighs of spiders, which, as they can be elevated and depressed at the will of the animal, probably are used as a kind of finger, when occasions require it."*

Besides constructing their varied snares, the spiders also use their silken web in the construction of their habitations, some of which are exceedingly ingenious. "Some species of spiders," M. Audoin remarks, "are gifted with a particular talent for building: they hollow out dens; they bore galleries; they excavate vaults; they build, as it were, subterranean bridges; they construct also entrances to their habitations, and adapt doors to them, which want nothing but bolts, for, without any exaggeration, they work upon a hinge, and are fitted to a frame.

"The interior of these habitations," he continues, "is not less remarkable for the extreme neatness which reigns there; whatever be the humidity of the soil in which they are constructed, water never penetrates them; the walls are nicely covered with a tapestry of silk, having usually the lustre of satin, and almost always of a dazzling whiteness. He mentions only four species of the genus as at present known: one which was found in the Island of Naxos; another in Jamaica; a third in Montpelier; and a fourth, that which is the subject of his Memoir, in Corsica; to which may be added a fifth species, found frequently by Mr. Bennett, in different parts of New South Wales.

* Kirby's Bridgewater Treatise, vol. ii. p. 185.

"The habitations of the species in question, are found in an argillaceous kind of red earth, in which they bore tubes about three inches in depth, and ten lines in width. The walls of these tubes are not left just as they are bored, but they are covered with a kind of mortar, sufficiently solid to be easily separated from the mass that surrounds it. If the tube is divided longitudinally, besides this rough cast, it appears to be covered with a coat of fine mortar, which is as smooth and regular as if a trowel had been passed over it; this coat is very thin, and soft to the touch; but before this adroit workman lays it, she covers the coarser earthy plaster-work with some coarse web, upon which she glues her silken tapestry.

"All this shows that she was directed in her work by a Wise Master; but the door that closes her apartment is still more remarkable in its structure. If her well was always left open, she would be subject to the intrusion of guests that would not, at all times, be welcome or safe; Providence, therefore, has instructed her to fabricate a very secure trap-door, which closes the mouth of it. To judge of this door by its outward appearance, we should think it was formed of a mass of earth coarsely worked, and covered internally by a solid web; which would appear sufficiently wonderful for an animal that seems to have no special organ for constructing it: but if it is divided vertically, it will be found a much more complicated fabric than its outward aspect indicates, for it is formed of more than thirty alternate layers of earth and web, emboxen, as it were, in each other, like a set of weights for small scales.

"If these layers of web are examined, it will be seen that they all terminate in the hinge, so that the greater the volume of the door, the more powerful is the hinge. The frame in which the tube terminates above, and to which the door is adapted, is thick, and its thickness arises from the number of layers of which it consists, and

which seem to correspond with those of the door; hence, the formation of the door, the hinge, and the frame, seem to be a simultaneous operation; except that in fabricating the first, the animal has to knead the earth, as well as to spin the layers of web. By this admirable arrangement, these parts always correspond with each other, and the strength of the hinge, and the thickness of the frame, will always be proportioned to the weight of the door.

"The more carefully we study the arrangement of these parts," adds Mr. Kirby, "the more perfect does the work appear. If we examine the circular margin of the door, we shall find that it slopes inwards, so that it is not a transverse section of a cylinder, but of a cone, and on the other side, that the frame slopes outwards, so that the door exactly applies to it. By this structure, when the door is closed, the tube is not distinguishable from the rest of the soil, and this appears to be the reason that the door is formed with earth. Besides, by this structure also, the animal can more readily open and shut the door; by its conical shape it is much lighter than it would have been if cylindrical, and so more easily opened, and by its external inequalities, and mixture of web, the spider can more easily lay hold of it with its claws. Whether she enters her tube, or goes out, the door will shut of itself. This was proved by experiment, for though resistance, more or less, was experienced when it was opened, when left to itself, it always fell down, and closed the aperture. The advantage of this structure to the spider is evident, for whether it darts out upon its prey, or retreats from an enemy, it is not delayed by having to shut its door.

"The interior surface of this cover to its tube, is not rough and uneven like its exterior, but perfectly smooth and even, like the walls of the tube, being covered with a coating of white silk, but much more firm, and resembling parchment, and remarkable for a series of minute

orifices, placed in the side opposed to the hinge, and arranged in a semicircle; there are about thirty of these orifices, the object of which, M. Audoin conjectures, is to enable the animal to hold her door down, in any case of emergency, against external force, by the insertion of her claws into some of them."

But the functions and instincts of spiders would of themselves furnish materials enough for a volume, so inexhaustible is the study which every department of nature supplies. The webs of the retiary or geometric spiders, for example, which we may presume each one of our readers has occasionally admired, when its radiating structure glistens with the dew of early morning, may be watched with great interest, from the first foundation of the net, by means of the stout radiating lines, to the completion of its singular spiral threads. But besides this ingenious structure which attracts the eye, the little weaver may be seen to construct a cell in some covered spot outside the web, but so close to it that, while it lies concealed there, it may be informed by the slightest vibrations of the lines of its snare, when any prey has been captured. In addition to those various uses, the spider also employs its silk in weaving the cocoon which incloses its eggs. This, as we have already said, it watches with a manifestation of maternal solicitude and care scarcely exceeded by any animal but man.

Besides all these remarkable evidences of creative wisdom in the appliances with which the spider is furnished, the microscope shows that the feet exhibit a very remarkable structure, being fringed with fine hairs, so arranged that it is able to walk on a ceiling, and climb with ease a pane of glass or other smooth surface. Examined under a powerful microscope, the slender bristles on the spider's foot are observed to terminate in hooks; and with these it is enabled to cling to a rough surface, and move with ease over walls and ceilings, setting its

snares in palace and cottage; and there patiently awaiting the coming of its prey. "The spider," says Solomon, "taketh hold with her hands, and is in king's palaces." We look upon the spider, under the influence of vulgar prejudice as a loathsome creature. Its ingeniously woven snare, when found in the corners of our chambers, loaded with dust, is an unsightly object which we hasten to sweep away. The spider's cob-web has indeed come to be the very symbol of indolence and neglect. It is also not without some reason, assumed as the representative of craft and dissimulation, lurking as it does immoveably within its den, waiting till some unwary fly is snared in its toils. Yet, with all this, the spider may no less fitly furnish an emblem of ingenious skill, and of patient persevering industry; nor does any class of examples, among all the endless appliances furnished by creative wisdom, exceed in wondrous contrivance and adaptation to the ends in view, those which we have selected from what pertains to the numerous family of arachnidans, which we meet, in the season of summer, under every tuft of grass in the hay field, spreading their nets on every bush, and labouring with unwearied patience in their solitary toils. We thus perceive that it is not needful for us to ransack the rarer wonders of nature in order to light upon the evidences of consummate wisdom and skill. We have only to pause at any moment, and fixing on one of the least attractive, apparently, among all the endless varieties of created beings, to subject it to patient and minute study, in order to find there proofs surpassing all that human wisdom or fancy could conceive of. We perceive in nature no husbanding of ingenuity and skill, such as is manifest everywhere in the works of man. The wheelbarrow, the cart, and the waggon are rudely put together, with little application of the devices of modern science for lessening friction, or increasing speed. It is in the railway train that we must look for the lubricating oil,

the polished axle and socket, the cushioned springs and drag, and all the most refined products of mechanical invention. So also is it when we compare the rude fisherman's craft, or the lighter-man's barge, with the merchant-brig, or the steam-ship. In all the works of man we perceive evidence of toil and cost which he has to expend in the production of every ingenious effort, and of the parsimonious expenditure of it only on those more elaborate means provided for the accomplishment of his most cherished and favourite designs. How totally different from these are the works of God. In them everything is alike perfect. Man is indeed made in the image of God, and endowed with capacities far beyond any pertaining to the living creatures subjected to his dominion; but his physical frame is not more wonderfully constructed than that of the ephemeron which fleets through its brief lifetime between the rising and setting of the sun. The leg of the beetle, the wing of the dragon-fly, the downy feathering of the moth or butterfly, or the spinning apparatus of the caterpillar or spider, each proves the liberal exercise of Divine wisdom in its construction, and shows how vast is the difference between that supreme power which called our world into existence at a word, and the laborious, gradual, and uncertain processes of mechanical construction, by which man elaborates his most perfect designs.

CHAPTER IX.

INSECT COMMUNITIES.

The spider is one of the most remarkable examples of perseverance and ingenuity exercised in solitude. We shall now direct our attention to some of the curious

insect republics, in which large communities are seen laboriously working together for the general weal. Of these the bees and the ants, are the most conspicuous, and attract our interest by many remarkable evidences of instinct, and curious co-operation for the accomplishment of their desired ends. The mathematical exactitude with which the untaught working bee constructs its cell, has already been noticed in a former chapter, and the procuring of honey, as well as the guarding of the hive, have been alluded to in some of our passing references in describing the characteristics of spring.

We shall glance very briefly at the remarkable community of the hive, which exhibits to us a well regulated monarchy under the sovereignty of a queen, with a division of labour and the apparent harmonious recognition of fixed laws, such as characterize only the most civilized and virtuous communities of man. One of the ablest of all the Greek philosophers, speaks of the bee and the ant, as possessing a more intelligent soul than most of the warm blooded animals, and a later Greek writer, Pisidius, asks: "who taught the bee, that wise workman, to act the geometer, and to erect her three-storied houses of hexagonal structure?"

The general economy of the population of the hive, exhibits the harmonious combination of some of the most extraordinary instincts, pertaining to any class of living creatures. The bees inhabiting a single hive are divisible into four classes, namely, the queen, the drones, the nurse-bees, and the wax-workers. The business devolving on each of these classes of the bee community is well defined, and liable to no misunderstanding or neglect. The commonwealth of the hive is no republic, but an absolute monarchy, of which the queen is the sole ruler, and the mother of its progeny. The drones may be described in familiar phraseology, as the courtiers and special attendants on the queen; their express purpose being the fecun-

dation of the queen bee, and the consequent securing of the new race of young grubs, which forms so prominent an object in all the occupations and labours of the perfect insect. Of the queens, although several are produced, no more than one is ever reared, the absolute monarchy of this singular community precluding any semblance of rivalry to the throne; and as the resemblance to the imperial sovereignty of human monarchies is thus complete, the correspondence of the number of the courtier drones, in comparison to that of the industrious members of the community is equally observable. The drones are found not to exceed in number above one to sixty of the whole; and thus impose no very oppressive burden on those who have to labour for their sustenance. The nurse-bees and wax-workers, are the labouring classes ot the commonwealth. Their duties bear so much general resemblance to each other, that their sub-division thus into two classes is only the result of comparatively recent observation. The distinction, however, is one of considerable interest, and adds another remarkable feature to the characteristics of this singular community. On the wax-workers the storing up of a sufficient supply of food for the winter entirely depends, while the nurse-bees expend the honey which they gather in feeding the young grubs, and supplying the wants of all those who do not leave the hive, including the whole class of drones. The wax-workers construct the combs, provide cells in which the queen deposits her eggs, and others in which to store up the winter's supplies. These are somewhat larger than the nurse-bees, and the observation of Huber and others, leads to the conclusion that they are an entirely distinct class, and that each follows its own special duties without impeding or interfering with the others.

Such is the constitution of this remarkable insect commonwealth; and the "busy bee," is most appropriately named, for it seems to be an absolute law of the singular

community, that no idler, or useless member, shall share in the advantages which they are thus leagued together to secure. It is strictly a division of labour at which they aim, and even their select class of courtiers are no longer tolerated, when they degenerate into an idle and unproductive aristocracy. This is one of the most singular phenomena pertaining to the instincts of the whole insect family, which belong to the season of summer. The sole duty of the drones, as we have said, is to render the queen bee fruitful, and this done they can make no further contribution to the wealth, or extension, of the hive. They have become mere idle consumers, and therefore, according to rigid bee-law, are no longer fit to be tolerated within an industrious community. Before, therefore, the labours of the summer are well begun, or any progress has been made in storing in their provident supplies for the succeeding winter, the capital law against idlers is most rigidly enforced. By means of these drones, along with their queen, the future increase of their numbers has been effectually secured, and the drones are no longer requisite in the economy of the hive. They amount in a hive of between six and seven thousand bees, to little more than a hundred, and these in the beginning of summer are doomed to destruction. In the month of July, or about the beginning of August, a sudden fury seems to take hold of the whole working classes, like some fierce red-republican revolutionary movement. The labourers who have heretofore contributed with the utmost assiduity and good-will to the wants of the courtier class, as we have termed them, are now actuated by an unappeasable wrath against them. They pursue the unhappy drones, chasing them from every corner to which they retreat, until at length the whole are driven to the bottom of the hive, where they are surrounded and slain by the insurgents, each of them being pierced with many wounds, and then flung lifeless from the hive. So comprehensive,

and yet discriminating is the antipathy manifested by the working bees at this period, against the whole race of drones, that they are affirmed by careful observers to tear open the cocoons of their pupæ, in order to destroy the male larvæ, and thus devote even the unborn aristocrats to destruction. It is exceedingly remarkable that instinctive emotions such as these, designed obviously for the removal of a class of insects which have already performed their natural functions, should partake so much of the character of one of those popular movements by which political revolutions are effected among men. In this, as in so many other departments of nature, we can only wonder at the economy of Providence, without attempting to fathom the precise purpose of the means employed. The butterfly, the gnat, the ephemeron, each expires soon after its functions essential to the continuation of the species have been exercised, and we would naturally expect something similar to take place in the hive, for the removal of the drones from the busy community, when they have ceased to play any necessary part, and remain only as a burden on the hive. But whatever difficulties may occur to some minds in considering the remarkable revolutionary movement, to which the idlers of the hive annually fall a sacrifice, it is unquestionable that it is the result of a discriminating instinct, bearing so close an approach to the results of human reasoning from experience, that it would be difficult to conceive of any improvement which reason could supply. This is seen when it happens that a hive has been deprived of its queen. It is then found that no such massacre takes place, and while the surrounding hives are seen to be strewed around with the dead drones, the whole of the males are preserved uninjured in the queenless hive, in order that on the nursing-bees rearing a young queen from the larvæ of that season, she may find the requisite attendance, and be able to perform all the

functions which devolve on the sovereign. In this discriminating reservation of the males under certain circumstances, we probably perceive the object for which their destruction is provided for by the direct co-operation of the working-bees, as they are thus guided by a discriminating instinct, which secures the preservation of the males throughout the winter, when it is rendered requisite for the fecundation of a new queen.

The advent of summer, with its abundant flowers, having been celebrated by the destruction of all who are incapable of turning its treasures to account for the good of the community, the labours of the year may be said to begin in earnest. It is not till then, though the season is so far advanced, and the honey-bearing flowers are already beginning to diminish, that the winter stores are begun to be laid in. The young larvæ are now beginning to quit their cells, and to take a part in the common duties of the industrious community; and the provident workers are immediately seen to clean out and repair the vacated cells, in order to turn them to account for holding the needful winter's supplies. All is now bustle and animation throughout the hive. The queen appears to bear an active part in setting the whole arrangements in progress. The waxen cells are repaired, and new ones are added, so as to supply abundant depositories for the honied treasures they now hasten to collect. All are familiar with the eagerness and assiduity with which the bee now pursues its task. Every flower is visited, and the clusters of the heath-blossom, or the rich tufts of the clover field, are ransacked by thousands, and rifled of their nectar. The bee may be also seen alighting on the ripe pear or plumb, where the wasp has already broken the outer rhind, or the birds have selected, according to their wont, the ripest of the fruit for their own repast. During the remainder of the summer season, and throughout the earlier warmth of autumn, this industrious toil is unceas-

ingly pursued. Watching at the entrance to the hive on a bright day, the working bees are seen constantly entering, some with their thighs laden with the rifted pollen or bee-bread, and all bringing home the honey which is to fill the cells for their winter supply. Others are at the same time setting off; and thus the daily additions accumulate at length, sufficient to supply all the community throughout the coming winter. They are no less careful for present than for future wants; and while the one party of labourers are busy building the waxen cells, the others may be seen bringing them food, which they furnish by means of the trunk, until they are satisfied. It is indeed remarkable how completely the whole community are able to communicate together, so as effectually to co-operate for the common ends they have in view. The instinctive combination for a common end has been already seen, in the case of the annual destruction of the drones; but both among the bees and the ants, a means of mutual communication appears to exist, answering all the purposes of language. This species of natural insect language has been made the subject of particular investigation; and Dr. Roget has communicated some interesting results of observations relating both to the ants and bees. "It has been conjectured," he remarks, "that the antennæ of insects are the organs of other senses besides that of touch. If an insect be deprived of its antennæ, it either remains motionless, or if it attempt to walk or fly, appears bewildered, and moves without any apparent object. Huber found that bees are enabled, by feeling with their antennæ, to execute their various works in the interior of the hive, where, of course, they can have no assistance from light. They employ these organs perpetually while building the combs, pouring honey into the magazines, ascertaining the presence of the queen, and feeding and tending the larvæ. The same naturalist observes, also, that it is principally by means of the antennæ that these

social insects communicate to one another their impressions and their wants.

The different modes in which ants, when they happen to meet during their excursions, mutually touch one another with their antennæ, appear to constitute a kind of natural language understood by the whole tribe. This contact of the antennæ evidently admits of a great variety of modifications, and seems capable of supplying all the kinds of information which these insects have occasion to impart. It would seem impossible, indeed, for all the individuals composing these extensive societies to co-operate effectually in the execution of many works, calculated for the general benefit of the community, unless some such means of communication existed. There is no evidence that sound is the medium of this intercourse; for none, audible to us at least, was ever known to be emitted by these insects. Their mode of conversing together appears to be simply by touching one another in different ways with the antennæ. Huber's observations on this subject are exceedingly curious. He remarks that the signal denoting the apprehension of danger, is made by the ant striking its head against the corselet of every ant which it chances to meet. Each ant, on receiving this intimation, immediately sets about repeating the same signal to the next ant which comes in its way; and the alarm is thus disseminated with astonishing rapidity throughout the whole society. Sentinels are at all times stationed on the outside of the nests, for the purpose of apprizing the inhabitants of any danger that may be at hand. On the attack of an enemy, these guardians quickly enter into the nest, and spread the intelligence on every side: the whole swarm is soon in motion, and while the greater number of ants rush forwards with desperate fury to repel the attack, others who are entrusted with the office of guarding the eggs and the larvæ, hasten to remove their charge to places of greater security.

When the queen bee is forcibly taken away from the hive, the bees which are near her at the time do not soon appear sensible of her absence, and the labours of the hive are carried on as usual. It is seldom before the lapse of an hour that the working-bees begin to manifest any symptoms of uneasiness: they are then observed to quit the larvæ which they had been feeding, and to run about in great agitation, to and fro, near the cell which the queen had occupied before her abduction. They then move over a wider circle, and on meeting with such of their companions as are not aware of the disaster, communicate the intelligence by crossing their antennæ and striking lightly with them. The bees which receive the news become in their turn agitated, and conveying this feeling wherever they go, the alarm is soon participated in by all the inhabitants of the hive. All rush forwards with tumultuous precipitation, eagerly seeking their lost queen; but after continuing the search for some hours, and finding it to be fruitless, they appear resigned to their misfortune; the noisy hubbub subsides, and the bees quietly resume their labours.

A bee, deprived of its antennæ, immediately becomes dull and listless: it desists from its usual labours, remains at the bottom of the hive, seems attracted only by the light, and takes the first opportunity of quitting the hive, never more to return. A queen bee, thus mutilated, ran about, without apparent object, as if in a state of delirium, and was incapable of directing her trunk with precision to the food which was offered to her. Latreille relates that, having deprived some labouring ants of their antennæ, he replaced them near the nest; but they wandered in all directions, as if bewildered, and unconscious of what they were doing. Some of their companions were seen to notice their distress, and approaching them with apparent compassion, applied their tongues to the wounds of the sufferers, and anointed them with their

saliva. This trait of sensibility was repeatedly witnessed by Latreille, while watching their movements with a magnifying glass."*

From these observations we perceive that insects have a means of communicating with one another answering all the purposes of speech, in as far as they stand in need of such a means of communication of their ideas to each other. The universal alarm, extending from one bee to another, until it has been communicated to the whole hive, on the loss of their queen, is a remarkable example of this. When such an event occurs, naturalists who have devoted their attention to the habits of the bee remark, that if there are no eggs or broods in the nest, so that it is impossible to repair their loss, or continue the species, all their faculties seem to disappear. To adopt language applicable to human beings under similar circumstances, they may be said to abandon themselves to despair. The object to which all their labours have been hitherto directed is no longer attainable. They cease, therefore, to prepare or work their wax, or to store their honey; and, the ties of the commonwealth being apparently dissolved by the loss of its head, they gradually disappear and die. This, however, is an object of extremely rare occurrence, as, if there be any brood in the combs, the bees can provide for themselves a new queen. It is conceived, indeed, apparently from well-founded evidence, that all the working bees are females, although only one becomes productive, and that this state, which pertains to the queen, depends on her being nursed in a peculiar way while in the larva state, and fed on a different food from the ordinary bee-bread on which the larvæ are nurtured. Having, accordingly, selected a worm about three days old, the bees proceed to construct a cell for it suited to its destined growth as a queen. In doing this they throw several cells into one, breaking down the

* Roget's Animal and Vegetable Physiology, vol. ii., p. 385.

adjoining cells, using the wax in the new structure, and unhesitatingly destroying such larvæ as may chance to interfere with the all-important purpose they have in view. Within the enlarged cell the worm undergoes its transformation to a nymph, and, on reaching maturity, the portal of the royal cell is unsealed, and the queen comes forth, ready to undertake the indispensable duties on which the reproduction of the species and the preservation and healthful industry of her thousands of obedient subjects depend.

A queen bee is said to lay from fifty to a hundred thousand eggs in a single season; an amount by no means inconceivable, or surpassing what many other insects are capable of. Linnæus, for example, was so struck by the rapidity with which decaying animal matter was removed by certain carnivorous insects, that he was wont to affirm that a dead horse would be devoured with greater expedition by three little flesh flies, and their immediate progeny, than by a full-grown lion. This, which is by no means an extravagant idea, entirely depends on the extreme fecundity and rapid development of the *Musca vomitaria*, or flesh fly. It is well ascertained that one female fly will produce at least twenty thousand larvæ, each of which will display a voracity similar to that already described in the young silk worm. In a single day it will devour so much flesh as to increase two hundred times its weight when born; and a very few days suffice for the production of a third generation. The rate of increase of insects in general, is indeed altogether marvellous to those who have given no previous consideration to the subject; and it is manifest that they are designed, in their various stages of development, to supply to other animals the food which is appointed for them by nature, otherwise such a rate of increase going on only for a few seasons, without any diminution of the whole progeny, would render a single fly sufficient to depopulate a kingdom!

One important result which necessarily follows from the multiplication of the occupants of the bee-hive, consequent on the numerous progeny of the queen in a single season, is the *swarming*, by which the hive sends off its colonies to establish new settlements similar to that in which they have been reared. The curious fact has been ascertained by the observations of Huber, that it is the old queen which leads off the first swarm, as if with parental anxiety for the welfare of the community over which she has ruled, she felt a keener sensibility than the rest to the dangers of the over-populous community. In her ordinary state the queen bee is observed to pass from cell to cell with slow and measured progress, as if in conformity to our ideas of queenly dignity. Previous, however, to swarming, this is succeeded by symptoms of extreme agitation. From some unknown cause, an entire change appears to have been effected on her, occasioned, as is supposed by some, from her recognition of the approaching emergence of several rival queens from the royal cells, which have been provided for rearing the future leaders of other swarms. By whatever direct cause the change is produced, it is obviously an instinctive prompting, essential for the wellbeing of the community. The queen is then seen traversing the combs with great agitation, and as she proceeds she appears to communicate the same to all the bees with which she comes in contact. At length a large body of them crowd to the entrance, and the queen passing out into the open air, the whole follow her until she alights on some suitable place, and there, if not disturbed by those who desire to transfer the industrious community of honey-makers to the garden-hive, they settle, and rear their future abode. The original hive being deserted by its queen, another takes her place, and she in her turn becoming the leader of a new swarm, the same process is repeated, until by successive swarmings the superabundant population of the

hive has been provided for beyond its bounds, and the remaining occupants settle down to pursue the provident labours of the year.

It may not be out of place here—though properly pertaining to the season of Autumn—to refer to another remarkable movement occasionally practised by this singular community of insects, wherein we discern a resemblance to the actions of the human race, no less striking than those we have already traced on the preceding pages; while at the same time it furnishes an interesting evidence of those unexpected proceedings under circumstances which would seem not to be provided for by the ordinary instints of the species, and therefore all the more closely resemble the results of human forethought and reason. However great a number of bee-hives be arranged together in the same garden, and even on the same stand, no confusion seems to be felt by the bees, nor difficulty in discerning their own proper hive. Among the hills in Cumberland and Westmoreland, or in the Highlands of Scotland, where the abundant blossom of the heath forms a rich store of nectar for the bees in August and September, the rambler will frequently find them flitting from flower to flower, with their pleasant hum, miles away from any locality where a hive exists; yet no sooner have they collected a sufficient store than they forthwith wing their way, without compass or pilot, straight to their own proper home. It is probable that a bee can recognise each companion of his hive, from the strangers that occupy the neighbouring ones, though to us all appear precisely alike. It is well known that a shepherd can tell each one of a large flock of sheep by the expression of its face, as readily as a teacher would recognise each pupil of his school; nor is it at all improbable that the diversity of countenance which is so recognisable among the human family, may run through all living creatures. As the year advances towards the season of harvest, the flowers

give place to seed and fruit, and warn the bees of the cessation of their natural supplies before the increasing cold forbids them to quit the hive. Now therefore they begin to draw on the stores so providently laid up during the abundance of summer. If, however, the season has been wet and cold, or any extraordinary cause has impeded the industrious labours of the working bees, so that their honey cells are still nearly empty, they may be seen flitting about between the sudden gusts of rain, striving to make up the deficiency in their winter stores from the few blossoms still to be met with on the bramble and other late-flowering plants. Many, however, perish from cold and wet, and may be seen clinging in a benumbed and feeble state to some shrub or flower where they have last alighted. The resources of the community proving thus altogether insufficient for their wants, they are driven in self-defence to the same predatory shifts as man resorts to under like circumstances, and endeavour to subsist by plundering their neighbours. A writer in the Encyclopedia Britannica, who furnishes much new and curious information regarding the habits of the bee, remarks:—"On these occasions the distressed bees often betake themselves to plunder. Spies are sent out to examine the neighbouring hives. Allured by the smell of honey, they examine the appearance and strength of its possessors; and, selecting the weakest hive as the object of attack, they begin a furious onset, which costs great numbers their lives. If the invaders should fail in their attempt to force the entrance, they retreat, and are not pursued by those they have assailed; but if they succeed in making good the assault, the war continues to rage in the interior of the hive, till one party is utterly exterminated; reinforcements are sent for by the invading army, and the bees from the neighbouring hives often join the assailants, and partake of the plunder. In a short time the whole of the enemies' magazines are completely emptied. If,

on the other hand, the invaders should be defeated, the successful party is by no means safe from the attacks of the bees from other hives, if any of them should chance to have mingled in the fray, and especially if they have once penetrated as far as the magazines; for, in that case, they are sure to return, accompanied with a large reinforcement; and the unfortunate hive that has been once attacked, ultimately falls a sacrifice to these repeated invasions."

The close resemblance, if not indeed the complete identity of many of these proceedings of this singular insect community, to those which human beings pursue under like circumstances, cannot fail to strike the reader, and impress him with a strong conviction of the inexhaustible richness of Providence in meting out to every living thing provisions abundantly suited to every necessity of its being, and making the instincts of the lowest in the scale oi animated being, fully equivalent, according to their necessities, to the abundant resources which reason and experience supply to the rational creation occupying the supreme place among the inhabitants of our planet.

The various communities of ants, which live together in sociable union, and provide during the summer the stores of winter, are scarcely less interesting to the entomologist, or the student of nature in general, than the occupants of the bee hive; though, from their stores being without value to man, they have equally escaped the minute attention, and the annual spoliation, to which the honey-makers have been subjected. Few, however, who have lived in the country, or possessed a garden where the opportunities of observation existed, have failed to notice the industrious little natives of the ant-hill plying their unwearied round of duties throughout the summer. They also, however, like the natives of the hive, display emotions akin to the passions that actuate the human race, and engage in deadly warfare, apparently with less

reasonable justification than is furnished for similar proceedings by the bees. The wars of the ants have attracted attention from a very early period, and have been noted by ancient writers, not without some of the marvellous additions to which such were prone; yet the reality, when narrated by accurate observers, with strict attention to truth, stands in need of no additions to excite our liveliest interest. The younger Huber, to whom we are indebted for many of the most remarkable discoveries relative to the habits of the bee, observes, with reference to the wood-ant,—"If we are desirous of beholding regular armies wage war in all its forms, we must visit the forests in which the wood-ant (*Formica rufa*) establishes its dominion over every insect within the neighbourhood of the colony. We shall there see populous and rival cities, and regular military roads diverging from the ant-hill like so many rays from a centre, frequented by an immense number of combatants of the same species, for they are naturally enemies, and jealous of any encroachment upon the territory which surrounds their capitals. I have witnessed in these forests the inhabitants of two large ant-hills engaged in spirited combat; two empires could not have brought into the field a more numerous or more determined body of combatants. The rival cities were situated about a hundred paces from each other, and alike in extent of population: what occasioned their discord I cannot pretend to say.

"Let us figure to ourselves this prodigious crowd of insects covering the ground lying between these two ant-hills, and occupying a space of two feet in breadth. Both armies met at half-way from their respective habitations, and there the battle commenced. Thousands of ants took their station upon the highest ground, and fought in pairs, keeping firm hold of their antagonists by their mandibles: a considerable number were engaged in the attack and leading away prisoners. The latter made

several ineffectual efforts to escape, as if aware that, upon their arrival at the camp, they would experience a cruel death. The scene of warfare occupied a space of about three feet square; a penetrating odour exhaled from all sides; numbers of dead ants were seen covered with venom. The ants, composing groups and chains, laid hold of each other's legs and pincers, and dragged their antagonists on the ground. These groups formed successively. The fight usually commenced between two ants, who seized each other by the mandibles, and raised themselves upon their hind-legs, to allow of their bringing their abdomen forward, and spurting the venom upon their adversary. They were often so closely wedged together, that they fell upon their sides, and fought a long time in that situation in the dust, till a third came to decide the contest. It more commonly happened that both ants received assistance at the same time, when the whole four, keeping firm hold of a foot or antennæ, made ineffectual attempts to win the battle. In this way they sometimes formed groups of six, eight, or ten firmly locked together, the group being only broken when several warriors from the same republic advanced at the same time, and compelled the enchained insects to let go their hold, and then the single combats were renewed: on the approach of night, each party retired gradually to their own city.

"Next morning, before dawn, the combatants returned to the field of battle, the groups again formed—the carnage commenced with greater fury than on the preceding evening, and the scene of combat occupied a space of six feet in length by two in breadth. The event remained for a long time doubtful; but about mid-day the contending armies had removed to the distance of a dozen feet from one of the cities, whence I conclude some ground had been gained. The ants fought so desperately that they did not even perceive my presence; for though I

remained close to the combatants, not one of them attempted to climb my legs, seeming to be wholly absorbed in the object of finding an enemy to wrestle with. During this furious warfare the common operations of the two colonies were not suspended, for the paths, which led to a distance in the forest, were as much thronged as in time of peace, and all around the ant-hill order and tranquillity prevailed. On that side alone where the battle raged were seen crowds of the colonists running to and fro, some to join the army and some to escort the prisoners. This war terminated without any disastrous results to the two republics. In fact it appeared that its duration was shortened by long-continued rains, which compelled each ot the belligerents to keep within their walls, and the warriors ceased to frequent the road which led to the camp of the enemy."*

The different proceedings in the warfare of the various ants, and remarkable facts which have been noted regarding them, such as one species seeming to make slaves of another, and the vanquished apparently offering tribute, and otherwise seeking to appease the victors, are so marvellous, that were we not told them on the authority of careful scientific observers, we would be inclined to regard them as the mere creations of fancy. Even as it is, however, it may be suspected that in some cases the interpretation of such phenomena, and the motives assigned to the little actors, have been too hastily assumed to correspond to those with which the observers were most familiar in their own race. Yet our observation of the remarkable habits and instincts of the bees fully prepares us to acknowledge the strict consistency of the following remarks on these combatants by the ingenious author of "Insect Miscellanies." After describing some of the combats between different species of ants, he remarks:—"Not the least wonderful circumstance connected with

* Insect Miscellanies, p. 335.

these insect battles is the instinct which enables each ant to know its own party, more particularly when the combatants on both sides are of the same species, and thousands of individuals mingle in the strife, who appear, at least to our senses, to be precisely alike in shape, size, and colour." Sometimes, indeed, according to Huber, they do attack those of their own party, but on recognising them immediately relax their hold; while it often happens that the individuals who have been the sufferers from this temporary error, caress their companions, for the purpose, it would appear, of appeasing their anger.

"The warfare, however, is conducted in various manners, according to the genius of the species engaged in it; and when a party of the wood-ant *(F. rufa)* attacks a party of the sanguine ant *(F. sanguinea)*, the manœuvring reminds us strongly of our own battles. The sanguine ants, in this case, go and await the enemy in little troops at some distance from the nest, advancing in a body without separating, and seize all those of their enemies who venture too far from the camp. 'The two parties,' says Huber, 'place themselves in ambuscade, and suddenly attack each other in turns; but when the sanguine ants perceive that the wood-ants are advancing in force against them, they inform those at the ant-hill, by messengers, of the need in which they stand of their assistance. Immediately a considerable army is despatched from the sanguine city, advances in a body, and surrounds the enemy. I have witnessed instances of this kind every day for several weeks, the ant-hills being at the same hedge, but at some distance from each other, and the combats renewed every day.'"*

We naturally smile at such accounts of the proceedings of these pigmy combatants; yet the description may also furnish a humbling lesson to ourselves, who, endowed with reason and intelligence, and instructed by the pre-

* Insect Miscellanies, p. 340.

cepts of Divine Wisdom, yet find so much that resembles our own violent and cruel wars, in the proceedings of the natives of two neighbouring ant-hills. May we not picture to ourselves some great being, an angel or archangel, looking down on our planet, and witnessing the wars of rival nations with just such a smile of wonder at the causeless folly of the belligerent antagonists. And yet to such a great and holy being the scene of human warfare must be a cause of sorrow rather than of mirth; for while the folly of it might well move angels to laughter, the crime and sin which it involves must far more strongly excite them to view with wondering wrath the contempt of rational beings for the dictates of reason and the laws of God.

We leave unnoticed many other instincts and habits of the ant and bee, as well as of other insects resembling them in their social life, which would equally well reward our investigation by their interesting disclosures. The remarkable instinctive antipathy of the queen bee to a rival, which influences the whole government of the hive, and appears to regulate the annual swarming of the new colonists, is well deserving of minute study. The mode of secreting the wax; of preparing, fitting, and sealing up the cells; of depositing the eggs, supplying with food the future worm, and providing for its safety until it reach maturity; as well as the singularly wise instinct, which so directs the fostering of the future leaders, that no two queens shall be simultaneously produced in the hive; —these, and many other phenomena observed in the singular insects, all proclaim the same great truths which we have traced in so many other departments of nature, and declare to us, in unmistakeable language, the hand that made them is Divine.

CHAPTER X.

INTERPOSITION OF THE CREATOR.

In reviewing the various phenomena of insect life, referred to in preceding chapters, we are naturally led again to the consideration of that remarkable substitute for reason in the lower animals, which we term instinct. There is, indeed, no department of our subject which furnishes equally strong proofs of the beneficent attributes, and the perfection of wisdom and power in the Creator, than that which relates to the instincts of animals. We see in it as clearly the overruling care of the Deity for his works, as we recognise the parental affection of the mother, and her relationship to the child, in the solicitude with which she watches over it, guarding it from every danger, and providing for all its wants. The sceptical philosopher, and still more, the ignorant and shallow sceptic, have conceived it to be derogatory to the Divine character to suppose the Supreme Being occupied continually in caring even for many, and much more, for all the petty insects that live out their brief summer day; but how mean an idea does the sceptic thus conjure up from his own false conceptions of greatness! How much nobler is it to conceive of the Supreme Being as the God and Father of all,—sympathising with, and caring for every created being,—and beholding, amid all the vast works of the universe, nothing too insignificant for his care, and nothing too great to be independent of his oversight and sustaining power. We recognise it as a noble thing to see some great man condescending to the wants and necessities of a little child, humouring its waywardness, and bearing with its peevish or perverse proceedings; and may we not behold the same, manifested in a manner consistent with the Divine Majesty, in that care of the universal

Father for all his creatures, which clothes the wing of the moth with its silvery down, teaches the silk-worm and the spider their ingenious arts; while, at the same time, it rules the motions of the planets, and regulates the course of myriads of suns through the immensities of space.

The dominion which has been conferred on man over the lower animals, places them in a certain, though far inferior sense, in the same relation to him, as he is to the Supreme Being. Yet how striking is the contrast between the conduct of the two masters! God exacts service from all his creatures, but it is a beneficent, wise, and altogether reasonable service. He demands of us implicit obedience to certain moral laws, and submission to like restraints; but while they are only unprofitable evidences of obedience in relation to Him, they are the true sources both of temporal and spiritual well-being. No man need be told that the commands, Thou shalt not steal, Thou shalt not kill, Thou shalt not sin, are, in reality, benevolent provisions for the happiness of man; and that thousands superadd to the poignancy of misery and bodily disease, the keener bitterness of reflecting that they have brought these on themselves, by their disobedience to the laws of nature and of God. The Divine Redeemer is sometimes referred to, in the mystical language of the Old Testament, under the name of Wisdom; and it is truly said, that wisdom's ways are ways of pleasantness, and all her paths are peace. "Divine providence," says Kirby, "has at its disposal the whole animal creation, and can employ all their instincts and their faculties to bring about its own purposes, both with respect to individuals and mankind in general. Man, who may be called, under God, the king of the visible creation, makes a similar use of the creatures that are placed at his disposal; of some, as the horse and the ox, he employs the physical powers; of others, as the bee and the dog, he avails himself of the instinct. Some he instructs how

they are to do his work; others, he takes as he finds them. So the Deity, it may be presumed, with a secret hand, guides some to fulfil his will, instructing them, as it were, because their unaided instinct would not alone avail, in the decree they are to execute, while others, merely by following the bent of their nature, do the same."

Yet it is a false conception of the Creator to suppose that special interpositions, and diverse degrees of supervision, of Providence, can be needed to carry on the government of creation; as though it were a machine set agoing, and then abandoned to the operations of certain forces, like a watch wound up and left to revolve with the relaxing of its spring. God is only justly viewed as the supreme and universal Creator, when we regard him as the soul of his creation, without whom all his works would be as the lifeless corpse, whose exquisite mechanism proves utterly unavailing to check its immediate decay the instant the soul has departed from it. In God all created things live, and move, and have their being. He knows no weariness in sustaining the universe; and can view no creature of his hands as too insignificant for his care, since even the mightiest archangel owes his being to the same word which has given its existence to the animalcule first revealed to us by the discoveries of the microscope. How completely is this idea borne out by the assurance of Divine protection thus conveyed by our Saviour to his disciples. After referring to the worthlessness of the sparrows, according to human estimation, he adds: "And one of them shall not fall on the ground without your Father. But the very hairs of your head are all numbered. Fear ye not, therefore; ye are of more value than many sparrows." Man, indeed, has been sometimes prone to look on the inferior animals—the lower creation, as he calls them—with an exaggerated idea of their inferiority to him; and hence to assume his right, not only to use them for his own ends, but even to inflict

suffering and cruelty upon them, and to derive a barbarous pleasure in their death. How unlike is this to the Divine character: and how awful would our sense of dependence be, if, instead of knowing the Supreme Being as a God of love, we were forced to conceive of him as an indifferent or a malevolent being, who felt no sympathy for the sufferings of the creatures he had created, or who was even capable of deriving a pleasure from their pangs, and experiencing enjoyment in their death! In this also, may man perceive his immeasurable inferiority to God; and we may feel assured of this, as of a truth beyond all dispute, that the inferiority of the meanest polype or mollusk, compared with man, is as nothing when contrasted with the immeasurable inferiority of man to his Creator. We know not, indeed, how many orders of superior beings there may be throughout the universe, all superior to ourselves. In other planets of our own system, beings may exist, endowed with senses all unknown to us, which may place them as much higher in the scale of being, as the language and reason of man elevate him above the animated creation of our own planet. It seems probable, indeed, that amid the vast universe which the astronomer labours to comprehend, there must be created beings, to whom our span of life of threescore years and ten, seems as brief as that of the ephemeron does to us, when we behold its passage from the cradle to the grave between the rising and the setting sun.

How delightful, amid such reflections, is the conviction which all nature forces on us, that the Supreme Governor of the universe is a being of infinite love, on whose care and goodness all may repose without a sense of apprehension or fear, and who has created even the weeds and wild-flowers to minister to the wants of countless millions of living creatures, while they serve also to gratify our senses and instruct our minds. "Apart from the import-

ant uses of vegetables in the economy of the world, plants are, as it were, the poetry of nature, the gilding and embroidery of the plains and valleys, the splendid ornamental arborescent plumes of the mountains. With that superabounding beneficence which the Author of Nature displays in all His arrangements, the vegetable world is not only essential to the existence of man, but it also ministers to his delight in the beautiful, as manifested in form, colour, and endless variety. There is a refinement and delicacy even in the vegetative economy of plants—their organic elements are more purely compounded, as regards the senses of man, than those of animals; the taste and odour of vegetable matters are, with very few exceptions, pleasing, and frequently exquisitely delightful; even their decay and decomposition is less offensive than that of animals. To plants we owe almost all the pure and ethereal sensations of smell. When we speak of the otherwise blank and inodorous air, we say it 'breathes of spices,' or 'of violets:' our finest essences, our most aromatic oils—our nard, cassia, and attar of roses, are all of vegetable origin. The same pre-eminence is given to the beautiful aspects of leaves and flowers. When the most enthusiastic poets sing of the exquisite beauty of their mistresses, they can only compare them to the rose, or to the lily; their ambition is to make them as blooming, or as fair as these—not fairer. When we wish to adorn the young and blooming bride, we deck her with the rose, or with the more modest jasmin or myrtle. When we desire to soothe our bereavements by paying honour to the corpse of the departed friend, we strew flowers of appropriate memorial on the grave. If we wish to recall the sensations of the past, it is by the green verdure of spring, the first blow of the cowslip, the first opening of the daisy; or we associate them with the luxuriant glow of the summer flowers—the cool, woodland glade, where the primrose and the green

moss plants grow, or the open woodlands, rich in all their leafy, summer prime."

We have already referred to important functions performed by plants in the economy of nature, forming as they do the link between animate and inanimate creation, and serving as the medium by which the deadly carbonic acid gas is transformed into an element essential for animal life. "It has been calculated that a human being, in the course of a year, changes 225 lbs. of carbon into carbonic acid, so that a thousand millions of men would consume 225 thousand million pounds in a year. And supposing, on a low calculation, that all the other animals on the earth consume double this quantity, we have then an annual consumption of 675 thousand million pounds of carbon, which, during the process of its chemical change, consumes 180 thousand million pounds of oxygen gas; to which may be added at least 40 thousand million pounds of coal, which, along with other combustible substances, will consume 400 million pounds more of oxygen. Hence we may take the consumption of oxygen in the course of three hundred years, at 660 billions of pounds, or about one-fifth of the present contents of the atmosphere; so that this enormous quantity, if not restored by the counter operations of plants, would in a few centuries produce a most sensible and alarming effect upon the animal creation.

"It is probable, too, that a pretty equal balance is maintained between the relative amount of vegetable and animal life upon the earth, so that the increase or decrease of the one does not greatly exceed the corresponding increase or decrease of the other; this, indeed, would be necessary, allowing that there goes on, as we have shown, a reciprocal action in the atmosphere mutually serviceable to both. In this way we may argue from the very constitution of organic existences, and especially on their dependence upon the atmosphere, that the co-existence of plants and

animals has been an arrangement from the very beginning; and we are enabled to do this, notwithstanding the crude and hasty speculations of the earlier geologists, who framed their worlds of fish, reptiles, insects and mammalia, as existing separately, in succession, or animals, as the earlier creation, contriving somehow to live without vegetables at all."

We cannot despise the researches of science, or speak lightly of the wondrous revelations which philosophy has made known to us. These we find, are as the opening of a new book to us, and the unsealing of a divine revelation wherein the works of God speak of their Maker, and created things are made to tell of their Creator. But it is the Christian philosopher who alone rightly reads these revelations; and who coming to them in the same child-like spirit as he approaches the study of the Book of God, wherein is made known his will in reference to man, derives from it also the spirit of devotion and the lessons of humility. We find that the speculations of the earlier geologists were crude, imperfect, and in many respects erroneous. In some points they seemed—to the delight of the sceptic—to be totally at variance with the scripture narrative of creation; but time has shown that they who rejoiced at such stumblingblocks were making a god of their own ignorance, and worshipping lies. How truly is it declared, "the fool hath said in his heart there is no God!" The enmity that is in his heart finds ready expression in the foolish triumph at such misconceptions of nature, and supposed discoveries of discrepancies and contradictions between the revelations of nature and grace. But the Divine Redeemer, when he would teach his disciples the true spirit of those who would be his followers, set a little child in the midst of them, and said to them, unless they became as that little child—humble, docile, loving, and believing—they could not be his disciples; and without adopting the same

spirit, we cannot be the disciples of nature, and learn of it what it is capable of telling us of its origin. We find, however, the longer we study it, that it spreads out the more largely before us, promising inexhaustible supplies of knowledge, wonder, and delight. "Besides the larger animals," says an intelligent writer from whom we have already quoted, "each of which species has a particular range of vegetable substances on which it feeds, it is calculated that almost every species of plant has at least five distinct species of insects or inferior orders of animals that live, and feed, and nestle in its structure. So regular is nature in her system of operations that the moment the sweet nectar is secreted in the cup of the plant the young insect that feeds on it comes forth from the egg. Other animals, again, are developed when the pollen dust is in perfection, on which they feed; and, lastly, some are generated to partake of part of the ripening seed. Some of these insects in return contribute essential services to the plant. Thus, bees, in going from plant to plant, serve to distribute the pollen or fertilizing dust from one of the same species to the other. It is related that since the common hive-bee has been established in Wellington District, New Zealand, the clover produces seed throughout all the district, which it did not do before the introduction of this industrious insect.

"The multiplication of animals on a soil, too, so far from encroaching upon its vegetable produce, seems on the contrary to have the effect of stimulating it to fresh activity. The Pampas of South America, at the time of its discovery by the Spaniards, exhibited the same character as they do at the present day—an immense plain with a shingly soil, covered in some places with grass, and with a few clumps of interspersed acacias. Its animals were a few scattered herds of guanacos, the condor, the ostrich, and innumerable small animals of the mouse family, with a scanty population of wandering

Indians. The Spaniards, on their landing, brought with them to this country about three thousand horses and cattle. These in a few centuries increased prodigiously, till now they cannot be less than twenty millions—cattle in a wild state, ranging over the endless plains, and horses often scouring the districts in troops of fifteen thousand. Yet with all this the vegetation has increased, not diminished; and in addition to the native plants, the common thistle of Europe has been introduced, and now, at certain seasons, covers thousands of acres with its unprofitable herbage. It is calculated that the hides alone annually exported from this region amount to sixty millions of pounds weight, and that the animals annually consume not less than eight billions of pounds of nutritive matter from the soil. Such would appear to be the stimulus of reaction of animal life on the vegetable. The same is illustrated in the numerous herds and dairy produce of the Alps, and in other pasturage and agricultural countries of the temperate zones, where the skill and activity of man has stimulated the soil and vegetables into redoubled action.

"Yet nature, after all, is the best regulator of the growth of plants, and nowhere do we find those more beautiful or more luxuriant than under her unrestricted care. Nowhere do we find those more appropriately disposed or more gracefully intermingled. As to artificial culture, however advantageous it may be to the pressing wants of man, it is at best but a war against the true life of plants, an infringement of many of those laws which nature has instituted for their proper government and stability. What, for instance, can be more unnatural than crowding so many millions of the same species of wheat or bean-stalks into one field. To do so, with any chance of impunity to the plant and soil, requires immense extra expenditure of manure and human labour. Again and again will nature rebel against this infringe-

ment, and hence the gaudy poppy, the 'blue bonnets,' the wild mustard, and innumerable others, will frequently rise up and endeavour, however unsuccessfully, to assert their native and legitimate rights to the possession of the soil. How delighted, too, is nature's child to look upon such a gay enamelled scene—how does its young eye drink in with delight the bright and glowing colours, red, yellow, blue, and violet, storing up associations never to be forgotten in after life, even when maturer years have impressed upon its mind more homely and economical notions of green fields and their crops of precious 'bread-stuffs!'" *

We perceive then that the vegetable world is no less under the guidance of what we may strictly enough term laws of instinct, than the animal world. God gives to man a reasoning power, and leaves him to some extent to exercise it freely, while he restrains the lower creation by fixed laws, and leaves them unconscious of responsibility, and incapable of error. The existence of that remarkable source of action in the lower animals which we term instinct, was not unknown, as we have shown, to the ancients, though they do not appear to have very precisely discriminated between its operations and those of reasoning. This, indeed, like all the other distinctions in nature, is not easily reduced to precision. We have seen that, while the boundaries between the animal and vegetable kingdom, for example, seem so clearly defined when we look at the most perfect developments of each, the boundary line is in reality so indefinitely traced, that science is compelled to recognise a debateable land where she fails to pronounce a certain judgment on the classification of its occupants. So, also, is it with the remarkable phenomena of instinct. At the one extreme, we find the vine, or the hop-plant, following the shifting pole, in search of support; and the flower courting the sun-beams, and closing its petals against night, or rain. At the other,

* British Quarterly Review, vol. xi., p. 352.

we find the sagacity of the dog, or the elephant, meeting novel difficulties with appliances such as reason alone seemed capable of suggesting, and apparently anticipating and thwarting dangers in so remarkable a manner, that even the scientific philosopher has found himself at fault, and has seemed compelled to resort to the belief in a special providence, to account for the wondrous results of canine fidelity, by which the life of man has so often been preserved by the services of his dog. Even those who have thought themselves most successful in suggesting explanations of the principles of animal instinct, have felt compelled to own how wonderful are the phenomena which it presents to our study. "There is not, in my opinion," says Addison, "any thing more mysterious in nature than this instinct in animals, which thus rises above reason, and falls infinitely short of it. It cannot be accounted for by any properties in matter, and at the same time works after so odd a manner, that one cannot think it the faculty of an intelligent being. For my own part, I look upon it as upon the principle of *gravitation* in bodies, which is not to be explained by any known qualities inherent in the bodies themselves, nor from any laws of mechanism, but according to the best notions of the greatest philosophers, is an immediate impression from the First Mover and the Divine Energy acting in the creatures."

This, however, cannot be properly regarded as furnishing any explanation of the nature or cause of instinct, further than as being a power implanted in the lower animals, and in each species, suited to its peculiar habits and wants, even as reason has been given to man, and yet, he also is dependent on Divine will, and subject to many operations of natural laws. But we understand so imperfectly the full effects which these exercise on ourselves that we may well hesitate to pronounce authoritatively on their precise modes of operation on other living beings, especially when we come to reason on phenomena

which bear so singular a resemblance to those mysterious evidences by which we most clearly recognise the activity of the human intellect and the existence of the soul. "Reasoning from Analogy," says Kirby, "it seems inconsistent with the customary method of the Divine proceedings with regard to man, and this visible system of which he is the most important part—for a being that combines in himself matter and spirit, must be more important than a whole world that does not combine spirit with matter—to act *immediately* upon anything but spirit, except by the intermediate agency of some physical though subtile substance, empowered by him to act as his vicegerent in nature, and to execute the law that has received his sanction.

"If we consider the effects produced by the great physical powers of the heavens, by whatever name we distinguish them: that they form the instrument by which God maintains the whole universe in order and beauty; produces the cohesion of bodies; regulates and supports the motions, annual and diurnal, of the earth and other planets; prescribes to some an eccentric orbit, extending, probably into other systems; causes satellites to attend upon and revolve round their primary planets; and not only this, but by a kind of conservative energy empowers them to prevent any dislocations in the vast machine; and any destructive aberrations arising from the action of these mighty orbs upon each other. If we consider further what God effects both upon and within every individual sphere and system, throughout the whole universe, by the constant action of those viceregal powers, if I may so call them, that rule under him, whatever name we give them; I say, if we duly consider what these powers actually effect, it will require no great stretch of faith to believe that they may be the *inter-agents* by which the Deity acts upon animal organizations and structures to produce all their varied instincts.

"An eminent French zoologist has illustrated the change of instincts, resulting from the modification of the nervous system, which takes place in a butterfly, in the transit to its perfect or imago state from the caterpillar, by a novel and striking simile. He compares the animal to a portable or hand organ, in which, on a cylinder that can be made to revolve, several tunes are noted; turn the cylinder and the tune for which it is set is played; draw it out a notch and it gives a second; and so you may go on till the whole number of tunes noted on it have had their turn. This, happily enough, represents the changes which appear to take place in the vertebral chord and its ganglions on the metamorphosis of the caterpillar into the butterfly, and the sequence of new instincts which result from the change. But if we extend the comparison, we may illustrate by it the two spheres of organized beings that we find on our globe, and their several instinctive changes and operations. We may suppose each kingdom of nature to be represented by a separate cylinder, having noted upon it as many tunes as there are species differing in their respective instincts—for plants may be regarded, in some sense, as having their instincts as well as animals—and that the constant impulse of an invisible agent causes each cylinder to play in a certain order all the tunes noted upon it: this will represent, not unaptly, what takes place, with regard to the development of instincts, in the vegetable and animal kingdoms; and our simile will terminate in the inquiry, whose may be that invisible hand that thus shakes the sistrum of Isis,* and produces that universal harmony of action, resulting from that due intermixture of concords and discords, according to the will of its Almighty Author, in that infinitely diversified and ever moving sphere of beings which we call *nature*. What, if these powers—employed as they are by the Deity so universally to effect his Amighty will in

* The Sistrum of Isis symbolized the elements.

the upholding of the worlds in their stated motions, and preventing their aberrations,—should also be the intermediate agents, which by their action on plants and animals produce every physical development and instinctive operation, unless where God himself decrees a departure that circumstances may render necessary from any law that he has established ?"*

But whether we adopt the idea of such intermediate agency, or of immediate impressions from the Divine energy, or creative power, or by whatever other imperfect form of language we seek to give expression to our ideas of such remarkable phenomena, we must still have recourse to God, as the source and centre of all creation and of all subsistence. Whether we learn to pass from instinctive operations, to physical causes, irritants, senses, and appetites, and thence to proximate causes, by which we may seem at length to discover distinct laws, we are still only taking a different path towards the centre, whither all lines of evidence converge, and at length arrive, as before, at God as the moving and sustaining power. It is very difficult for us to reason adequately on this subject where it rises from the animal instincts to their creative source, and while many have striven by strict laws or analogies of science to find a satisfactory explanation, the idea of the whole being dependent on the increasing influences of creative superintendence has been thought to be derogatory to the honour of the Divine Being. The following striking and ingenious argument is employed by Mr. Kirby, in enforcing this idea: "When we examine a time-piece contrived by a skilful artist containing within it various wheels and other movements, all acted upon by one main spring or pendulum; by means of which, influencing all, seconds, minutes, and hours are indicated as they pass; and the latter are struck successively, and repeated if required: we admire the work,

* Kirby's Bridgewater Treatise, vol. ii. p. 241.

but more the art and hand that contrived and executed it; but our admiration would be much diminished, if, instead of these effects being produced by the action of a main spring or pendulum upon its organization, if I may so call it, it was necessary that the maker of the machine, or one of his operatives, should always be present to move the hands or strike the hours. So it seems most to magnify the power and wisdom of the Creator, if we suppose him to act by physical means in all cases above the intellect of the animal. If he governs the physical universe by such means, is it much to suppose, that by the same he moves a bird, or a bee, to glorify him by their admirable instincts? Where action is indeed from the Deity *upon spirit*, as upon the soul of man, in a certain sense, it is *by spirit;* either immediately as by the Holy Spirit; or mediately as by an angelic nature; but *below* spirit, it is surely most consonant to everything that we see and know, that it should be by an agent below spirit."

But we may be permitted to inquire if this mode of reasoning is not based too exclusively on an idea as if God were such a being as ourselves; equally imperfect in his powers, and limited in his faculties? We acknowledge that the creed of the Romanist dishonours God when it requires the interposition of angels and saints, of the Virgin, and of the Pope, the priests, and all the ecclesiastical machinery of the Church, between God and man: may we not also dishonour the Creator by the mediate laws and physical means which we insist on interposing between him and his creatures? It would indeed be a clumsy expedient of the supposed skilful artist to leave, after all, the most important movements of his time-piece to depend on the constant interposition of an assistant, who would weary in his task, blunder in his computations, and find his appetites, his need of rest, and all the physical laws of his own nature, at variance with such requirements. But surely we can perceive in this no just ana-

logy to the sustaining powers, and the direct operation of the Divine will, on the works of creation. To justify the argument we must conceive of an artist so skilful that by the force of his reason, by means of which the whole mechanism of the time-piece is devised, it shall also be executed, so that the mental and mechanical operations shall be one; and the time-piece having been thus, as we may strictly term it, *thought into being*, we must next assume that by a continuance of the same exercise of thinking or reasoning, its whole mechanical actions shall be maintained and regulated at his will. Such is some faint similitude to the ideal of creation; and if we can further suppose that the reasoning mechanist can continue the mental operations on which the movements of his time-piece depend, without his whole mental powers being absorbed thereby—as we are able to walk, and to eat, under the guidance of the mind, while it remains sufficiently unfettered to allow of our reading or thinking on entirely different subjects at the same time,—we would not then find any cause for the diminution of admiration because the continuous correct action of the machine depended on the unceasing oversight of the maker. Thus it is, we think, that the continuous and immediate operations of the Divine will in the whole works of creation are to be conceived of. We are taught to believe in the omnipresence of God. Is not this an intelligent idea of his being everywhere present? We live in him. He sustains us. His will is the law on which all other laws depend. No extent of being can exhaust his power of supervision, no amount of thought can suffice to preoccupy the Divine mind. His care is over all his works. He clothes the lily; he cares for the sparrow; he instructs the spider, which takes hold with her hands in kings' palaces. He fills the appetite of the young lions, when they couch in their dens, and abide in the covert to lie in wait. He provides for the raven his food, when his young ones

cry unto God. Dead things are formed from under the waters, and the inhabitants thereof. Hell is naked before him, and destruction hath no covering. He stretcheth out the north over the void, and hangeth the earth upon nothing. He bindeth up the waters in his thick clouds; and the cloud is not rent under them. He holdeth back the face of his throne, and spreadeth his cloud upon it. He hath compassed the waters with bounds, until the day and night come to an end. The pillars of heaven tremble, and are astonished at his reproof. He divideth the sea with his power, and by his understanding he smiteth through the proud. By his Spirit he hath garnished the heavens; his hand hath formed the crooked serpent. Lo, these are parts of his ways; but how little a portion is heard of him? the thunder of his power who can understand?

CHAPTER XI.

VERTEBRATED ANIMALS.

THE variations in the organic structure of animals, and the relative development of some of the parts most essential to the functions of life, or to the habits of the several species, furnish important elements of classification to the naturalist. So far has the science of comparative anatomy been carried, that it is found to afford sufficient data in dealing with the fossil remains of extinct animals, to enable the geologist, who only obtains a few mutilated fragments, to reconstruct from these the perfect animal, assign it to its proper species, and sometimes even from a single bone or tooth, to determine the nature and habits of the race to which it belonged. In the organs essential to animal life, the first, and most indispensable, would

appear to be those required for the nourishment of the body: foremost of which is the stomach. This last organ, as we have seen, is sometimes the only evidence of distinct organic structure which we can detect in the lowest forms of animal being, as in the polypes, where a small bag or little mass of jelly, containing a single cavity or stomach, constitutes the whole animal; while the polygastric animalcules consist solely of a number of stomachs within one bag. Besides those indispensable for the nourishment of the animal, there are also the organs of motion, and those designed for procuring food, and as the essential frame-work or support of the softer parts. It is from the latter that we derive the classification of the higher animals which we are now to consider. The infusories, polypes, polygastric animalcules, and many other of the lowest forms of animal life, are destitute of any crustaceous or bony structure for the support or protection of the body. But to atone for this the most of them are less liable to injury than those of more delicate organization: the polypes as we have seen, being only multiplied by being cut in pieces, and common worms also, exhibiting no apparent signs of injury when cut in two. Some curious instances occur where these soft animals protect themselves by means of an artificial covering, thereby manifesting a curious instinct in providing for their defence. The caddis worm, or larva of the brown May-fly, which passes the first stage of its existence in shallow streams, collects round its body a covering of straws, sticks, and small shells, which it works together so as to form a strong protecting sheath for its body. The *Terebella conchilega* affords another example of the same class. It is a soft worm which burrows in the sand of the sea-shore, and is found to cover its tender skin with fragments of shells and small pebbles, which it secures together by means of a mucilaginous fluid exuding from its skin. The hermit-crab, again, illus-

trates another mode of artificial defence provided by soft-bodied animals for their protection. Having no covering of its own, it seeks out an empty shell on the sea beach, which it forthwith takes possession of as its own dwelling.

These examples belong to different divisions in the classification of the animal kingdom: the polypi and infusoria pertaining to the fourth or lowest division, styled the *Radiata;* while both the hermit-crab, and the larva of the May-fly, are classed in the higher division of the *Articulata*, under the different sub-divisions of crustacea and insecta. Still higher than those are reckoned the second division, mollusca, or soft-bodied animals, including the varieties of shell-fish, the cuttle, nautilus, &c., and above this is the comprehensive first division, which includes all animals with a skeleton of bones, and a vertebral column or spine.

In the first class, MAMMALIA, of the division vertebrata, are, first, Man, styled the *Bimana* or two-handed. Next the *Quadrumana*, or four-handed, including the whole monkey tribe. Next to these are the *Carnaria*, including the *Carnivora*, or flesh-eaters, and other sub-divisions; and next to these are the pouched animals, the opossum, kangaroo, &c., having a sort of external womb, into which their young retreat, and from this they are styled *Marsupiala*, or pouched. The *Rodentia*, or gnawers, such as the beaver, the squirrel, the mouse, and the hare, derive their name from the peculiar form and mode of use of their teeth, while the *Edentata*, such as the sloth, or ant-eater, are so styled to indicate that they are toothless. Besides those, there are among the mammalia, the *Pachydermata*, or thick-skinned animals, such as the elephant, the tapir, and the horse, and the *Ruminantia*, including all animals which chew the cud, such as the camel, ox, deer, sheep, and goat. Last of all are the *Cetacea*, such as the oceanic whale, the dolphin, porpoise.

narwal, &c., which, though resembling the true fishes in many of their habits and modes of life; yet, like all the other mammalia, bring forth their young alive, and suckle them. The whole class of birds, *Aves*, of reptiles, *Reptilia*, and of fishes, *Pisces*, are also reckoned in the same division, all of them possessing in common the bony skeleton, and vertebral column or spine, with a brain and nervous system, and generally the whole five senses, however greatly differing in other respects.

In proceeding to the investigation of this important division of animated nature, we find an entirely new class of evidences from those which we have heretofore been considering as the proofs of intelligent design, which creation reveals to us. In some respects the difference appears altogether wonderful, as we follow on our course in tracing the footsteps of nature, and ascend to those higher classes of animated creation which we are now to consider. Yet no evidences of intelligent and benevolent design, can surpass those to which our attention has already been directed, in the wonderful results of instinct, as manifested among so many of the insect order; though we find proofs of more elaborate structure, and of an organization adapted to higher faculties and more extended operations. In the whole division of the articulata, which includes the insects, and the crustacea, as well as other classes, we seem to find certain descriptions of animals designedly constructed on totally opposite principles from those which we are now to consider. In the former the soft parts are entirely internal; and are inclosed and protected by a solid crust or shell, or a horny covering, which at once supplies an effectual armour and defence against injury, and unites the whole by an effective rigid support, to the surfaces of which the organs of motion are attached. In the vertebrata on the contrary, all those rigid, bony parts, which give mechanical support and precise form to the soft fleshy muscles,

as well as points of attachment, and centres of motion, are concealed by the softer organs; and an entirely different and inferior means of defence is applied to their outer surface. In one respect only, is this arrangement departed from in man, and most of the higher animals; and here the reasons for such deviation from the principles on which the whole division of vertebrata appears to have been formed, are abundantly apparent. This deviation and return, as it were to the principle on which the substantial frame-work and bony covering of the *Crustacea*, and other classes of the *Articulata*, are formed, is made for the protection of the brain, which, along with its immediate prolongation, the spinal marrow, are encased in a bony structure, enclosing them and guarding them against all injury. It is remarkable, however, that this apparent return to the characteristics of the articulata, occurs for the defence of an organ, of which they are almost without exception, entirely destitute. The nervous system of articulated animals consists of a series of cords, passing from the various extremities, or points of attachment of the organs of motion, and uniting with a central cord, in a series of knots or ganglia. These occur in each segment of the body, and appear to be analogous, in many respects, to the brain of the higher vertebrated animals. Hence it is that the articulata are so much less affected by dismemberment than animals of the higher division. Each segment of their body has in many respects an independent sensitive existence, so that when the body of a worm, for example, is divided into two or more parts, each part retains the faculty of sensation, and the power of voluntary motion; or when the head of a fly is taken off, it is thereby deprived of the organs of sight, and of the feelers and organs of feeding, but otherwise moves about at will. From this we perceive the means by which sub-division is possible in certain of the lower forms of animal life, without injuring the vital principle

of the different portions. In vertebrated animals, however, these ganglia or centres of the nervous system, are all concentrated in the brain, on which, accordingly, depend the entire functions of sensation, perception, and voluntary motion; and though we are utterly unable to determine, with any satisfaction, how the relations between mind and matter are preserved, there can be no doubt that certain affections of portions of the brain appear to be connected with the exercise of the affections and passions, and of the sentient and intelligent principle. The delicate and extremely sensitive organs of sight, hearing, taste, and smell, are also in immediate contact with this primary and essential organ of sensation, and are safely lodged within the bony structure which defends it. The connection of this central organ with the rest of the system, is effected by means of the nerves, consisting of white cords, or bundles of threads of medullary matter, enveloped in sheaths or coverings of membrane, which ramify from the brain to the extremities and whole external surface, and convey all impressions received from external objects to this ultimate organ of sensation.

No subject is more calculated to impress us with a sense of the wondrous wisdom of creation, and of the dependence of nature on the continual sustaining power of the Creator, than the investigation of the organization of the higher animals, and of the wonderful human frame. We have there the cerebral organ responding to every pulsation of sound, to every action of light, to the delicate perceptions of the organs of taste and smell, and directing a corresponding response to every sensation of touch throughout the whole external frame. We perceive also the body guarded by an external cuticle or scarf-skin, entirely callous, and therefore incapable of exciting any feeling of pain, and immediately beneath this are the nervous papillæ of the cutis or inner skin, wherein the sense

of touch resides, and which are acutely sensitive to the slightest pressure or contact, and capable of being made the source of extreme pain. Here also, however, we perceive most distinctly the useful and providential design of this sensitiveness to pain, as the monitory guide to self-protection. This is most strikingly shown by the fact that the internal organs of the body are only sensibly affected by those impressions which have a tendency to injure their structure. "Tendons and ligaments, for example, are insensible to many causes of mechanical irritation, such as cutting, pricking, and even burning: but the moment they are violently stretched, that being the mode in which they are most liable to be injured, they instantly communicate a feeling of acute pain. The bones, in like manner, scarcely ever communicate pain in the healthy state, except from the application of a mechanical force which tends to fracture them." Then, again, we discover within the same body the great central organs of circulation—the heart, with its elaborate system of veins, arteries, and valves, on which the constant flux and reflux of the life-blood depend; and the lungs, by which the no less essential respiratory circulation is kept up. We know that the interruption of either of these essential functions of life, for only a very few minutes, is sufficient to deprive us of life—to banish from this wondrous frame that mysterious vital principle on which its own existence, as well as our actions and perceptions, depend; and to release from this fleshly mansion that far more mysterious soul, which not faith alone, but even our own self-consciousness and untaught reason, assure us is destined for immortality, and is an indestructible creature of God. Yet these vital motions go on unheeded and unaided by us; every second the heart propels through the system, like a great engine, the blood impregnated with the oxygen of the air, and receives back the dark venous blood, to be reimpregnated in the lungs

by the air inspired by the mouth and nostrils. All the higher animals perform the essential process of breathing from ten to twenty times every minute of their lives; and an ordinary healthy man receives into his lungs, within the same brief period, ten cubic feet of air, which is again discharged, deprived of the oxygen taken up by the blood within the lungs; so that it has been calculated he inspires within fifty years one hundred and sixty-six tons of air, consumes eighteen tons of oxygen, and discharges nineteen tons of carbonic acid, containing about eighty times his own weight of carbon.

Those processes scarcely depend in any degree on the human will, and proceed altogether apart from our own consciousness; so that except from the pulsation which may be felt at the breast, or at the exposed artery at the wrist, we have no indication to our own direct consciousness of those vital processes which unceasingly go on throughout life, from the first moment of existence until the last. Let us consider for a moment the mechanical impediments to the circulation of the blood. It passes through our body in pliant flexible tubes, which are bent and moved about by every motion of our limbs. When we run, or leap, or wrestle, every joint and muscle is thrown into violent action, and it would seem as though the possibility of the circulation continuing freely at such times was altogether inconceivable. Yet at no time is it more complete. When we run, or walk rapidly, the lungs are brought into more quick and active play, the blood circulates more rapidly, and the whole delicate and wondrous machine responds to every volition of the mind. The ventricle of the human heart contracts from seventy to eighty times in a minute, and forces the vital fluid through our whole system as with the regular strokes of a steam-engine. The force with which this vital action occurs would fill the ignorant mind with alarm, if suddenly made conscious of it; yet it is the very element

of health. Some idea of the power by which the constant circulation of the blood is maintained, may be formed by examining its operations in some of the larger mammalia. "Consider," says Paley, "what an affair this is when we come to very large animals. The aorta of a whale is larger in the bore than the main pipe of the water-works at London Bridge; and the water roaring in its passage through that pipe is inferior in impetus and velocity to the blood gushing through the whale's heart. An anatomist who understood the structure of the heart, might say beforehand that it would play; but he would expect, from the complexity of its mechanism, and the delicacy of many of its parts, that it should always be liable to derangement, or that it would soon work itself out. Yet shall this wonderful machine go on, night and day, for eighty years together, at the rate of a hundred thousand strokes every twenty-four hours, having at every stroke a great resistance to overcome, and shall continue this action, for this length of time, without disorder and without weariness. To those who venture their lives in a ship, it has often been said that there is only a plank between them and destruction; but in the body, and especially in the arterial system, there is in many parts only a membrane, a skin, a thread." Yet this is all that is needed. The wonderful piece of mechanism has been devised by infinite wisdom, and, sustained by the vital principle breathed into it by the Creator, it moves on through the whole period of existence, fulfilling all the functions of its being without our even being conscious of the processes on which our life every moment depends.

Insects, as we have seen, have not a true brain, but only a variety of central ganglia, or knots of conjunction of nerves, and neither have they heart or lungs, but instead of them a dorsal vessel, which runs along their body. On each side of this are spiracles, or tubes, opening by a series of holes outside the abdomen, and through these

the air is received into the blood: while animals of a still lower grade appear to absorb air directly through their porous skins, and have no system of circulating organs. Nearly the whole of our knowledge in regard to those interesting and important subjects, is entirely the result of very recent observation. Even the true understanding of the circulation of the blood, is, as is well known, solely the fruit of modern discovery. To the thoughtful mind this single fact must be sufficient to impress strongly a sense of dependence on Him in whom we have our being. How does it enlarge the distance which separates man from God, to perceive that the vital functions on which his existence every moment depends, not only proceed healthfully and regularly without any direction or voluntary impulse of his own, but that they had thus regulated the life of man, and maintained the existence of his race, for thousands of years before even the most intelligent and thoughtful were able to discover how these most important functions of life were performed. By the minute ramifications of the arteries and veins, the necessary materials for the growth and renewal of the frame, are every moment supplied to all parts of the body. The arteries, on the left side of the heart, carry out the red blood, or blood impregnated with oxygen from the lungs, into the minutest extremities, by what are styled the capillary arteries; and from these minute extremities, the blood, now changed to a dark purple colour, is taken up by the veins and returned to the right side of the heart, to be anew passed into the lungs and returned with its supplies of vital and renovating power. This blood thus circulated by means of the heart and arteries to every part of the body, contains all the elements of the animal frame, and distributes them with unerring regularity and precision to each part of the system. To the bones it gives off lime; to the muscles, albumen; to the skin, gelatine; and to the liver, carbon. On them also no less

directly depend the saliva, the chyle, the tears, and also the milk in the mother's breast. Well may we exclaim, "We are fearfully and wonderfully made!" Fashioned by a Divine Mechanist, with a curious wisdom which makes the utmost ingenuity and inventive skill of man appear but as the feeble attempts of infancy in comparison; and preserved by a continuous care and oversight, which we only fail to regard as miraculous, because it is unceasing.

Compared with this vital machinery, what is the most perfect work that human mechanist ever framed? Look at the mighty steam engine, by means of which the ship is propelled across the Atlantic, heedless of wind or tide, uniting the old and new worlds, and reducing the vast distance between them to a few days' journey! This wondrous power devised by man, and one of the greatest triumphs of human skill, justly excites universal admiration; and we build monuments, and dedicate institutions, in honour of the man who invented it. But, compared with the engines of God's invention, how poor and incomplete it seems! It must have its stokers, to supply for it the place of lungs and constantly renew its expended fuel; it must also have its water, from whence to generate steam; and an endless oiling, and polishing, and renewing of joints, and hinges, and plates. Man, who made it, must be constantly aiding and superintending, and directing all its motions; and, after all, its revolving paddles, on which the motion finally depends, are so clumsy a contrivance when compared with some of the simplest of nature's contrivances, such as the web-foot of a duck or goose, that they waste nearly a third of the power produced by the engine; some of the paddles being employed as they enter the water, in lifting up the vessel, and others as they emerge from it, in lifting the water; so that they serve only to retard what they should propel, and to subtract from the velocity of true motion. In all other re-

spects, comparison leads to the same conclusions; and the investigation of the vital functions of even the meanest creature, is sufficient to show how great is the contrast between the works of God and those of man. "The communications of the capillary arteries with the veins," says Dr. Roget, "are beautifully seen, under the microscope, in the transparent membranes of frogs or fishes. The splendid spectacle, thus brought within the cognizance of our senses, of unceasing activity in the minutest filaments of the animal frame, and of the rapid transit of streams of fluid, bearing along with them minute particles, which appear to be pressing forwards, like the passengers in the streets of a crowded city, through multitudes of narrow and winding passages, can never fail, when first beheld, to fill the mind with astonishment; a feeling which must be exalted to the highest admiration, on reflecting that what we there behold is at all times going on within us, during the whole period of our lives, in every, even the minutest portion of our frame. How inadequate, then, must be any ideas we are capable of forming of the incalculable number of movements and of actions, which are conducted in the living system; and how infinite must be the prescience and the wisdom, by which these multifarious and complicated operations were so deeply planned, and so harmoniously adjusted!"

The evidences which animal and vegetable physiology furnish with reference to natural theology, are all of the most striking description, commending themselves at once to the intelligent student of nature, with an unanswerable force. Those functions, however, which we have been considering here, do not, in the higher animals, depend on any variation of the seasons for their vital action; but a comparison of some of these, and of the organs on which they depend, with those of the inferior animals, furnishes us with some interesting evidence of the methods by which the Creator manifests his care over all his works,

and apportions to those creatures which appear to be inferiorly endowed, such gifts as abundantly serve as an equivalent, and endow them with faculties fully equal to all the necessities of their existence. We have seen, for example, the great differences in the development of the nervous system of the higher and lower animals. The brain, which seems to be indispensable to all the functions of sensation, perception, and voluntary motion, in the former, and undoubtedly forms the organ by means of which the mind carries on all its operations in relation to external nature, and maintains its connection with matter, is nearly wanting in most of the lower animals, and appears to be totally absent when we reach the lowest divisions in the scale of animal life. The brain appears to increase in size, in proportion to the manifestation of intelligence in the animal. That of the dog, for example, is large, and that of the elephant is five times the size of the brain of the rhinoceros. This rule does not, perhaps, invariably hold true in so far as regards mere bulk of cerebral mass, though, as a general rule, it may be affirmed to be strictly true. The brain of the mouse, for example, is unusually large, without being accompanied with a corresponding degree of intelligence, though it is by no means deficient in acuteness and cunning; and is easily tamed and made familiar with man.

It is not, however, in these animals with largely developed cerebral organs, that we find the manifestations of wonderful instinct which have attracted our notice in previous chapters, but in the inferior articulata, with their systems of nerves and ganglia, showing the deficient sensibilities which accompany an inferior organization, and capable of being mutilated, and deprived of all the organs in which the senses appear to reside, without the vital functions being otherwise affected, or voluntary motion ceasing. In this, therefore, as in some of the peculiarities of their organization, we must recognise a compensating

process, by which the Creator has equalized the capabilities of every living thing, in so far, at least, as to render their ability to enjoy life fully equal to their capacity of enjoyment; so that we are justified, even when judging of God from our partial views of a system rendered imperfect by our own sins, in assuming that all nature witnesses to his wisdom, power, and unchanging, all-embracing love. One important advantage derived from the internal situation of the skeleton of the vertebrated animals is, that it admits of unlimited extension without derangement of the organs, or the necessity of any cessation of their power, the softer muscles, and all the most delicate organs expanding gradually and insensibly along with the strong bony frame destined to support the whole. In the articulated animals, on the contrary, as we have already seen, the softer parts are internal, and are entirely covered in with a solid unyielding crust, or horny shell, which, while it furnishes a perfect means for their protection and mechanical support, admits of little or no enlargement. On every step, whether simply an expansion by increasing growth, or some of the remarkable transformations which the insect class periodically undergo, this outer armour has to be thrown off, and replaced by an entirely new covering. The needful provision for the advancement of the insect through all the varied stages of growth and change, though differing from that of the vertebrata, and inferior in character, is yet complete of its kind, and fully answers all the purposes in view; so that, if we could suppose an insect to reason on its process of development and final completeness, it would as little desire to throw off the horny armour which protects it from injury, or to evade the successive stages of its larva, chrysalis, and perfect state, as we wish to have our soft muscles and delicately sensitive cutis encased in a crustaceous covering, hinged and jointed like the armour of a medieval knight; or to pass from infancy to manhood by

a series of leaps, instead of the gradual steps by which we rise from the state of infantile dependence to maturity. Even the soft caterpillar four times bursts its outer skin as it increases in size before it quits that for the chrysalis state; and its new covering has in like manner to be rent and thrown aside before it can reach its maturė state, and enter on the full exercise of its highest functions. We see, however, something analogous to this peculiar characteristic of the inferior articulata, in the mode of development of the organ connected with the finer senses and the highest functions of man and the superior vertebrated animals. The brain of an infant is not greatly inferior in size to that of a full-grown adult, and reaches its utmost proportions at an early period; while the skull, which is to protect it, is in a very imperfect state at first, the brain of an infant having a thin transparent membrane as its sole covering and protection on a considerable part of the top of the head. The plates of the skull are also entirely detached, and only held together by the enveloping skin, so that the infant may thus far be considered in a state somewhat analogous to that of the articulata in their earlier and imperfect stages of being.

In considering the various manifestations of intelligence, reason, or instinct, which are severally displayed by the different orders of animate creation, we perceive some interesting proofs of that equalization of happiness, as well as of powers of action, by which the inexhaustible wisdom and benevolence of the Creator are frequently manifested. Reason is that which distinguishes the highest of all animated beings from the rest, and the cerebral development, on which its manifestation evidently depends, is also seen, though in an inferior degree, accompanied in certain of the lower animals with wonderful evidences of a species of reason, which it is impossible to confound with mere instinct. We speak, accordingly, of the "half-reasoning" dog, or elephant, and are familiar

with hundreds of instances in which the sagacious companion of man has evinced powers of reflection, reasoning, and forethought, which put all our arguments on the exclusive possession of a rational soul at defiance. These remarkable manifestations of a species of intellectual development in the lower animals, appear, however, to be almost exclusively shown in a domesticated state. The ox, the sow, the goose, and the duck, when transferred from a wild state to the care of man, lose their natural habits without acquiring others, and sink into mere feeding animals, fit to be fattened for the table. But the dog, the horse, and the elephant, appear to rejoice in the willing service of man, and to acquire an intelligence and sagacity from their intercourse with him, which was unknown to them in their natural state. It is not, however, in these animals which appear to approach most nearly to man in his highest faculties, that we find the remarkable development of the curious artistic powers of the spinner, the weaver, the felter, and the builder: but, as we have said, in the lower forms of animated being where the brain, which we regard as the chief instrument by which all intellectual operations are carried on, is wanting. "If we survey the different tribes of the animal kingdom," says Kirby, "we shall find a vast difference between them with respect to intellect. That wonderful pulp, which of all substances is alone able to respond to incorporeal agency; to receive and store up the information collected by the organs of sensation, that it may be ready for future use, and which is the seat of the intellectual faculties, that wonderful pulp appears under very different circumstances in the different classes of animals; but it has not been made evident that the acuteness of the intellect, though in some instances it seems to do so, depends altogether upon the comparative volume of the brain; for that of the mouse, compared with its size, is greater than that of the half-reasoning

elephant. Man, indeed, generally speaking, has the largest brain of all animals, but it seems a singular anomaly that persons of very weak intellects have often disproportionately large heads, indicating a great volume of brain. When we leave the vertebrated animals, we find the nervous system, in most, materially altered and degraded, so that more power is given apparently to instinct and less to intellect. In other animals, as we descend, the nervous system becomes more and more dispersed, so that in those at the foot of the scale we discern no traces of intellect, and very few of instinct; and only so much apparent sensation as is necessary for the purposes of nutrition and reproduction. For if we pay due attention to the proceedings of animals, we shall find that those whose nervous system is cerebral usually exhibit the most striking proofs of intellectual action, are most capable of instruction, and are less remarkable for the complexity and intenseness of their instincts; while those of the next grade, whose nervous system is ganglionic, as far as we know them, though not devoid of intellect, are endued with a much smaller portion of it, while their instinctive operations are all but miraculous, and that where the nervous system is still less concentrated both are greatly weakened, till at the bottom of the scale they almost disappear. From hence it seems to follow that extraordinary instinctive powers are not the result of extraordinary intellectual ones.

"But when we reflect further, that even in cases where the instincts are most complex and wonderful, the animal practises them *infallibly*, without guide or direction, and is as expert at them when it first emerges into life, as when it has been long engaged in the practice of them; it follows that it must be instructed in them from the first moment of its existence in the state in which it exercises them, by an infallible Teacher. The bee, the moment it emerges from the pupa, begins to collect honey and pollen,

and to perform all the other manipulations that belong to her instincts.

"In the higher animals the case is somewhat different. When they emerge into life, from the womb, or from the egg, it is usually in a state of helplessness, in which at first they can do little or nothing for themselves but suck, or receive food from, their dam. As their organization developes they gradually gain new powers, till they arrive at their acme, or age of puberty.

"The young beaver generally remains with its parents till it is three years old, when they couple, and build a cabin for themselves and offspring. The unfledged bird remains quietly in its nest, and is content to receive its food and warmth from its parents, but no sooner are its feathers grown, and its beaked prow and plumy oars and rudder fit it to win its way in the ocean of air, than, incited by parental exhortations, it makes the attempt, and henceforth is equal to support itself, and to fulfil the biddings of instinct, as well as of intellect and appetite. This *storge* stimulates the parent animal while its care of its young is necessary to them and then ceases. This is therefore chiefly instinctive; but in the most intellectual of all animals, where instinctive love ceases, rational love begins; and care and anxiety for the welfare of our offspring, and affectionate regard for their persons, continue after they cease to have any need of our help and attention."

We cannot, however, overlook the fact, that even in their wild state the higher animals learn from experience, and cannot therefore be assumed to be guided solely by instinct. The fox grows more cunning with years, and learns to avoid the snares and to elude the hunters, by means altogether unknown to its inexperienced offspring. The hare grows more shy and more expert in its motions, when the sporting season exposes it to new dangers, and the old stag eludes the hunters by devices which are manifestly derived from former experiences in the chase.

In all these actions we discover proofs of an intelligence pertaining to the higher animals, showing the exercise of faculties akin to the reasoning powers of man, however inferior in degree. The whole subject, however, is one of difficulty, when we attempt to reason it out to its full conclusions, for we have seen that the bees, under novel circumstances, forsake their wonted habits, and provide for unexpected wants much in the same way that the most intellectual of all animals is wont to do in like circumstances. But whatever difficulty we may experience in drawing the true line of distinction between reason and instinct, we can be at no loss to recognise the bearings of the varied examples here referred to, in enforcing the same line of argument by which we have arrived in former chapters at some idea of the attributes of the Creator, as manifested in his works.

CHAPTER XII.

FUNCTIONS AND HABITS OF BIRDS.

We have had under consideration some of the most remarkable instincts and habits of birds, as well as the singular proofs of design displayed in their gradual development in the egg, when considering the phenomena which pertain to the season of spring. We shall now direct our attention to others, some of which strictly belong to the succeeding summer season, while others are naturally suggested from their associations with the same. Foremost among these are the interesting displays of parental instinct which accompany the care of the young until they quit the nest, and finally forsake the parent birds. The care with which the female bird tends her offspring has often been referred to as a striking illustration

of affectionate solicitude. The reader cannot fail to remember the touching allusion of our Saviour, when he wept over Jerusalem, and in his tender sorrow for the doomed city of the chosen but rebellious nation, exclaimed,—"How often would I have gathered you, as a hen gathers her chickens under her wings, but ye would not!" A more animated, and no less beautiful comparison occurs in the triumphant description of God's love to his people, which Moses spake in the ears of the congregation of Israel in his song of triumph:—"Remember the days of old, consider the years of many generations: ask thy father, and he will show thee; thy elders, and they will tell thee. When the most High divided to the nations their inheritance, when he separated the sons of Adam, he set the bounds of the people according to the number of the children of Israel: for the Lord's portion is his people; Jacob is the lot of his inheritance. He found him in a desert land, and in the waste howling wilderness; he led him about, he instructed him, he kept him as the apple of his eye. As an eagle stirreth up her nest, fluttereth over her young, spreadeth abroad her wings, taketh them, beareth them on her wings: so the Lord alone did lead him, and there was no strange god with him."

The beautiful allusion here describes the eagle exciting her young eaglets to quit the nest, and try, for the first time, to make use of their wings in flight. It is a most striking illustration of fond parental solicitude, and yet deriving its whole force and beauty from its truthful adherence to nature. A lively account of the actual scene of the training and exciting the young eaglets to flight, has been given by Sir Humphrey Davy, who had the good fortune to witness it, during one of those rambles in the Scottish Highlands which furnished some of the striking incidents recorded in his Salmonia:—"I once," says he, "saw a very interesting sight above one of the crags

of Ben Nevis, as I was going on the 20th of August in the pursuit of black game. Two parent eagles were teaching their offspring, two young birds, the manœuvres of flight. They began by rising from the top of a mountain in the eye of the sun; it was about mid-day, and bright for this climate. They at first made small circles, and the young birds imitated them; they paused on their wings, waiting till they had made their first flight, and then took a second and larger gyration, always rising towards the sun, and enlarging their circle of flight so as to make a gradually extending spiral. The young ones still slowly followed, apparently flying better as they mounted; and they continued this sublime kind of exercise, always rising, till they became mere points in the air, and the young ones were lost and afterwards their parents to our aching sight."

How apt a lesson does this suggest! No illustration of the solicitude of affection, derived from the conduct of the Christian parent, could surpass, in true force, this example of the fierce bird of prey fluttering over her young, spreading abroad her wings, and exciting her eaglets to try their powers of flight, and ascend on their young wings far up into the blue expanse of heaven. It seems as if it scarcely needed the promptings of fancy to suggest to us the idea of the Christian parent, pointing heavenward as she seeks to guide the thoughts of her young offspring upwards, enlarging the circle of their thoughts, and directing them ever towards the Sun of Righteousness, in whose light she seeks to see them rejoice.

The eagle does not generally exhibit much ingenuity or skill in fashioning its nest, though in care and solicitude for its young it is surpassed by no other bird. Wilson, the American Ornithologist, thus describes a nest of the bald eagle, which he examined:—"In the month of May," says he, "while on a shooting excursion along

the sea-coast not far from Great Egg Harbour, accompanied by my friend Mr. Ord, we were conducted about a mile into the woods to see an eagle's nest. On approaching within a short distance of the place, the bird was perceived slowly retreating from the nest, which we found occupied the centre of the top of a very large yellow pine. The woods were cut down, and cleared off for several rods around the spot; which circumstance gave the stately, erect trunk, and large, crooked, wriggling branches of the tree, surmounted by a black mass of sticks and brush, a very singular and picturesque effect. Our conductor had brought an axe with him to cut down the tree; but my companion, anxious to save the eggs, or young, insisted on ascending to the nest, which he fearlessly performed, while we stationed ourselves below, ready to defend him in case of an attack from the old eagles. No opposition, however, was offered; and on reaching the nest, it was found, to our disappointment, empty. It was built of large sticks, some of them several feet in length; within it lay sods of earth, sedge, grass, dry reeds, &c., piled to the height of five or six feet, by more than four in breadth; it was well lined with fresh pine tops, and had little or no concavity. Under this lining lay the recent exuviæ of the young of the present year, such as scales of the quill, feathers, down, &c. Our guide had passed this place late in February, at which time both male and female were making a great noise about the nest; and, from what we afterwards learnt, it is highly probable it contained young even at that early time of the season.

"A few miles from this is another eagle's nest, built also on a pine tree, which, from the information received from the proprietor of the woods, had been long the residence of this family of eagles. The tree on which the nest was originally built had been for time immemorial, or at least ever since he remembered, inhabited by these

eagles. Some of his sons had cut down this tree to procure the young, which were two in number; and the eagle soon after commenced building another nest on the very next adjoining tree, thus exhibiting a very particular attachment to the spot. The eagles, he says, make it a kind of home and lodging place in all seasons. This man asserts, that the grey, or sea-eagles, are the young of the bald eagles, and that they are several years old before they begin to breed. It does not drive its young from the nest like the osprey, or fish-hawk; but continues to feed them long after they leave it."

The driving of the young from the nest, which is here referred to, forms what may be styled the concluding lesson which all solitary birds of prey give to their young. We have already referred to the obvious necessity for the solitary habits of those animals which live by rapine and carnage; and this has been fully provided for in the instincts which guide them. Even a single pair of eagles in the vicinity of a pastoral district, becomes an intolerable nuisance, from the destruction they effect in providing for their own wants and supplying their young; we can readily suppose, therefore, what would be the case if the whole of their young were to remain with them, and increase in numbers year by year. But no sooner are the eaglets fully able to subsist without the parent birds, than the latter drive them away from the district; and they hasten, in obedience to their own natural instincts, to choose for themselves a locality in which to hunt for their own prey, and to rear their young in due season.

Nearly all the actions of the lower animals appear to be performed without any extraneous instruction, and solely by means of that singular impulse of nature, which we term instinct; and into the manifestations of which we have already made some investigation. In the training of the young we see this spontaneous, unreasoning intelligence, not only informing the parents how best to rear

their tender offspring, but also how to instruct them in the first steps by which they enter on active life, and employ their own faculties in moving about and providing for themselves. The stork has been observed, like the eagle, to watch over its young brood, and incite them to try their strength, and commit themselves to the air when their wings are sufficiently grown to bear them. When they venture on their first flight, the old stork may be seen to lead them in small circles about the nest, guiding them back to perch on it before they are exhausted. This education by the parent stork, is said to be continued during a considerable period, preparatory to the final trial of their strength, when they join the whole migratory flock and wing their way to spend the winter in a warmer climate.

While, however, we admire these interesting manifestations of parental instinct, it cannot be doubted that the instructions of the parent birds can at best only accelerate the flight of the eaglet or young stork; even as the efforts of the parent only very partially aid the infant in rising to its feet and running about erect: a movement which, after all, is quite as often suddenly undertaken, as if from some instinctive impulse, as in consequence of the incitement of the parent or nurse. The full fledged bird would need as little incitement to fly, as the little duckling does to take to the water almost as soon as it is able to walk to the margin. This view of the question has been urged with interesting illustrative remarks by one of the observant contributors to the Library of Entertaining Knowledge. "In the case of a brood of ducklings," says he, "it might be plausibly alleged, that their parents taught them to swim, because the mother may be seen swimming before them as their leader, and the little things all paddling after her according to their strength and agility. But, in order to prove this view to be correct, it would be indispensable to show that the ducklings

could not swim till they were instructed by their mother, which clearly appears not to be the case, for a duckling, as soon as it acquires the requisite strength of foot, which occurs a very short time after it is hatched, takes to the water and swims as dexterously as its mother herself can do. Nay, it can not only swim so as merely to keep itself afloat, but it knows, without any instruction, how to proportion the frequency and force of the strokes of either foot so as to carry it to any part of the pond it chooses, as accurately as if it were profoundly acquainted with the mathematical problems of the composition and resolution of forces. No instruction nor imitation of the parent will account for this, inasmuch as ducklings hatched in an oven will take to the water as readily as those tended by a female duck; and, in the common occurrence of their being hatched under a hen, they will swim away and leave their foster-mother on the bank of the pond in utter despair for their safety. This proves not only that they can swim without instruction, but in opposition to the most earnest solicitude of their sole instructress. We have witnessed a similar case, no less in point, in a brood of turkeys hatched by a goose, which their foster-mother, as was natural, was desirous of leading into the water; but this they refused as obstinately as ducklings do to quit the water when recalled by a hen."

We must, however, distinguish between such instinctive actions of animals and the mere vital motions of plants, otherwise we shall come to regard them as mere machines. However perfect the instincts of animals be, they are always exercised with a certain amount of discrimination, necessary to adapt them to the precise circumstances in which they are called into use, and which more nearly approach to intelligent reasoning as they rise in the scale of being. The training of the parent eagle may not be without its use both in inciting the eaglet to commit itself buoyantly on its new fledged wings, and to

pounce on the first prey that comes within its reach, though we cannot doubt that the eaglet, when so far advanced that its wings are capable of the soaring flight witnessed by Sir Humphrey Davy, if left to itself, would not be long of putting them to trial. It is no less worthy of notice, however, in illustration of our present subject, that such parental solicitude appears to be a source of lively enjoyment. The parent birds sympathize in the progress and exercise of the fully developed powers of their young brood with manifestations of pleasure which can in no degree be ascribed to mere impulses of instinct. They are evidently emotions akin in kind, though inferior in degree, to those which stir the human heart with so lively a sense of interest and joy. This, therefore, we cannot fail to recognise as an evidence of the Divine benevolence which provides so largely for the enjoyment of every living creature, and by such means converts the essential duties, and even the toils and struggles of life, into the sources of the purest pleasure.

William Smellie of Edinburgh, an enthusiastic naturalist of last century, gives the following very interesting account, in his Philosophy of Natural History, of an instance of strong parental affection witnessed by him in the case of a pair of sparrows, whose young brood he had carried off in the nest during their absence :—" When I was a boy," says he, " I carried off a nest of young sparrows, about a mile from my place of residence. After the nest was completely removed, and while I was marching home with them in triumph, I perceived with some degree of astonishment, both the parents following me at some distance, and observing my motions in perfect silence. A thought then struck me that they might follow me home, and feed the young according to their usual manner. When just entering the door I held up the nest, and made the young ones utter the cry expressive of the desire of food. I immediately put the nest

and the young in the corner of a wire cage, and placed it on the outside of a window. I chose a situation in the room where I could perceive all that should happen without being myself seen. The young animals soon cried for food. In a short time, both parents, having their bills filled with small caterpillars, came to the cage; and after chatting a little, as we do with a friend through the lattice of a prison, gave a small worm to each. This parental intercourse continued regularly for some time, till the young ones were completely fledged, and had acquired a considerable degree of strength. I then took one of the strongest of them, and placed him on the outside of the cage, in order to observe the conduct of the parents after one of their offspring was emancipated. In a few minutes both parents arrived, loaded, as usual, with food. They no sooner perceived that one of their children had escaped from prison, than they fluttered about and made a thousand demonstrations of joy, both with their wings and with their voices. These tumultuous expressions of unexpected happiness at last gave place to a more calm and soothing conversation. By their voices and movements, it was evident that they earnestly entreated him to follow them, and to fly from his present dangerous state. He seemed to be impatient to obey their mandates; but, by his gestures and the feeble sounds he uttered, he plainly expressed that he was afraid to try an exertion he had never before attempted. They, however, incessantly repeated their solicitations; by flying alternately from the cage to a neighbouring chimney-top, they endeavoured to show him how easily the journey was to be accomplished. He, at last, committed himself to the air, and alighted in safety. On his arrival, another scene of clamorous and active joy was exhibited. Next day I repeated the same experiment, by exposing another of the young ones on the top of the cage. I observed the same conduct with the remainder of the brood, which consisted

of four. I need hardly add, that not one either of the parents or children ever afterwards revisited the execrated cage."

No one can have observed the flight of a young brood of sparrows, attended by the parent birds, without being convinced that it is a source of abundant delight to the latter. They flit about them with every manifestation of exuberant joy, and apparently invite them to fly about, with a cry not unlike that with which the hen calls her chickens to follow her. The care and anxiety exhibited by the latter, is sufficient to prove beyond doubt the provident maternal affection manifested by birds in general. In its ordinary state, the common domestic hen must be regarded as a stupid bird. Its natural wild habits appear for the most part to have been lost by its domestication, without being replaced by others, and it, accordingly, presents little in its daily proceedings to attract an observer's attention. Beyond the habitual return to roost, it does little else than pick up the food which lies so invitingly at hand in the barn or stable-yard. The wild bird whose nest is invaded, ceases after a time to lay, and is easily made to abandon its nest if disturbed, but the domestic hen will continue to lay throughout the season, if its eggs are removed, or will equally readily sit on any round objects bearing some remote resemblance to them, as on its own proper eggs. Yet this same bird, when once its maternal instincts have been crowned with success, and it is surrounded by a young brood, seems to become wary, intelligent, and courageous. Though stupidly timid before, it will now peck at any intruder that threatens to molest its young, and will even fly at any strange dog that ventures to approach. Its constant care and assiduity are remarkable, and its affection, as we have seen, has been selected by our Redeemer as the symbol of the noblest and most divine of all manifestations of love. Similar displays of parental care have been observed in

the rook, the swallow, the goldfinch, the woodwren, and numerous other birds.

Many other illustrations of our subject might be derived from the habits and instincts of birds during the season of summer; but these will suffice to indicate their nature and to illustrate their bearing. When the labours and parental instincts of the birds have been fully rewarded, and the young brood has taken flight, the old birds separate, and their notes become greatly less frequent or pleasing. Some of them, however, such as the redbreast, continue their song throughout the year; and the thrush, the wren, and the blackbird, are all heard in note long after all the parental duties have been fulfilled. Whatever other reason, however, be assignable for the songs of birds, there can be no question that they are always a sign of pleasure, and therefore it may be expected that they will be more rarely heard in winter, when the birds bear their full share in the rigour of the season, and frequently suffer also from the deficiency of food. In addition to these reasons, the nightingale, the whitethroat, and others of our most musical summer visitors, disappear on the approach of winter, so that our woods are silent, not because of the song having ceased, but from the songster having transferred it to another land. But besides the songs, we must also distinguish, as entirely apart from them, the language of birds. The former are the notes of joy, which convey to all hearts so keen a sense of pleasure, when heard in spring or summer; while the latter is indicative of many varied feelings and desires. There is the well known cluck of the hen, when she calls her chickens, and her monotonous notes of pride with which she announces the laying of an egg. Many, and perhaps all birds, have some similar notes. The cries of fear or alarm, with which many smaller birds announce the approach of a hawk or owl, are of this nature; and the hen turkey has even more variety of notes than the

common hen, in warning or inviting her brood, and guiding them in her daily rounds. Gregarious birds, such as the rooks, the gulls, and even the sparrows; and all those which migrate, as the swallows, cranes, wild geese, and wild ducks, appear to have peculiar notes which may be called their gathering cries, by means of which stragglers are recalled, and the clamorous flock encourage and excite each other during a lengthened flight, or in the course of their habitual pursuits. The peculiar scream which is uttered by the wild geese, during their annual migratory flights, is frequently heard during the night, and is described by those who have listened to it, as having a singular effect on their minds, when heard in the darkness, amid the shrill gusts of wind often experienced on the approach of winter.

Wilson, the American Ornithologist, mentions a curious instance of a wild goose, which was wounded and captured by a farmer on Long Island. He placed it among his domestic geese where it soon became quite tame and familiar. One day, however, in the following spring, when the flocks of wild geese migrate toward the north, the captured goose overheard the note of the leader of one of these flocks, and spreading its wings it mounted into the air, and was speedily out of sight. The farmer gave up his goose for lost, and thought little more about it; but he chanced to be standing in his barn-yard, in the succeeding autumn, when he saw a flock of these wildgeese returning towards the south. Just as the flock passed over his head, he observed three geese detach themselves from the rest, and after wheeling round several times, alight in the middle of the yard. Imagine his surprise and pleasure, when, by certain well-remembered marks, he recognised in one of the three, his long lost fugitive; accompanied, as he had no doubt, with her offspring reared during her absence in the remote north, and now returning with them to share the sweets of civilized life.

The same mode of communicating with one another on the approach of danger, or other occasions of mutual interest, is found to pertain to all gregarious birds. The idea of all such birds having a chosen king or leader, and appointed sentinels to warn them of danger, finds considerable support from the most careful observations. Rooks, for example, appear never to go off on a foraging excursion without their selected guards; and so vigilant are these rook-sentinels, that it is extremely difficult to approach within gun-shot, without putting the whole to flight. Similar sentinels have been long observed among the cranes, plovers, and even the sparrows. When a flock of the latter active little depredators alight in a field of grain, or establish themselves in the neighbouring hedge-row to pursue their depredations at leisure, it will be invariably found that one or more of them remain perched on some high spray, from whence they can watch the approach of any foe. The instant that an intruder comes in view, the wary sentinel utters his well known quick chirrup, and the whole flock are off in the utmost trepidation. They may be observed also on such occasions to fly with a wary skill, somewhat like that employed by a retreating party of sharp-shooters, who have been skirmishing with the advanced guard of the enemy, and find that they are in danger from the approach of the main body. They do not set off in open flight, but by a sudden and rapid movement, get off about a gun-shot distance, where they have no sooner alighted than the vigilant sentinel resumes his watch, and if the intruder still advance, the warning chirrup again gives them notice, and the whole are once more on the wing. Most of our readers must have occasionally witnessed this in a country ramble As they walk along between the tall unpruned hedge-rows, there is a sudden rush of a whole flock of sparrows from the hedge a few yards before him. As he proceeds they again take to flight from their new resting-place with

equal precipitation and apparent alarm; and after repeating this several times and finding the intruder still advancing, they at length take to flight, and entirely abandon for the time the point of danger. A similar proceeding may be observed when a cat, or other stealthy depredator, is creeping along underneath the hedge row; but the most lively and interesting scene of this kind, is when a hawk, or still more, an owl, is abroad. The former is a source of unmitigated danger, and all the feathered tribe evince the utmost manifestations of fear. The hen is seen running off with the utmost celerity and trepidation, calling to her little brood with the peculiar note that warns of danger, and huddling them all under her protecting wings. The little birds in the grove announce in like manner the vicinity of the foe, and all the notes of gladness and calls of hunger are alike silent, until the enemy has disappeared, or carried off his prey. It is otherwise, however, when the owl has ventured forth in daylight. The whole flock of little songsters seem to discover that they have got their enemy at an advantage; and their proceedings may not inaptly be compared to a crowd of mischievous school-boys, assembled round a drunken man. While enjoying their sport at his expense, they still betray a conscious fear of his superior powers, which they are not without some dread of seeing displayed against them at any moment. So it is with the triumphant flock of finches, sparrows, robins, wrens, &c., round the unfortunate owl, when blinded with the glare of the mid-day sun. They chirp and chatter and wheel about their enemy with a sort of malicious joy, that is seemingly enhanced by the fears which mingle with their triumph; until at length their foe makes way to some shady recess, or effects a retreat to his own favourite perch in the ruined castle, or ivied belfry tower. Pliny, whose observations on natural history, are not unmingled with evidences of credulity and a love of the marvellous,

relates of the sentinel-cranes, appointed to watch during the excursions of these gregarious birds, that they stand on one foot, and clasp a little stone in the other, so that, should they chance to sleep they would let this fall, and thus be awakened and rebuked for their negligence. This, however, may be set down among the credulous errors of the Roman naturalist; and indeed it is the result of one of the admirable provisions of nature for the safety of birds, that they are not liable to lose hold during sleep. The natural habits of birds lead them to sleep roosting on the branches of trees, and even the domestic poultry though spending the whole day on the ground, retreat at night to their perch. In this position, the weight of the body, when thrown back on the bent limbs, tends to tighten the tendons, and fix them more securely on their perch; and these are only relaxed by the bird standing up; so that their safety during sleep is as effectually secured on the lofty branch of the tree, as is that of the hare in the grassy form beneath. The same cause would not indeed operate to tighten the muscles of the sentinel crane, but it would sleep without difficulty under similar circumstances, and most probably without dropping anything it might grasp in its lifted claw.

But the various cries of warning, invitation, and summons to feed, or challenge to combat and threat of defiance, which admit of being termed with the utmost propriety, the language of birds, may be studied with great interest in the poultry yard. The common dunghill cock, as he is somewhat contemptuously termed, is both a handsome and an interesting bird; and would attract our lively attention, were it not for our familiarity with him, as well as the interference with his natural habits, consequent on his ordinary mode of rearing. The great courage of the cock is well known, and he appears invariably to tolerate no rival male bird within his dominion. He answers with the most fearless bravado, to the crow

of a distant rival, and engages in fierce and deadly combat should he intrude among his flock of hens. He rules them in like manner with proverbial strictness, admitting of no dereliction from his domestic laws; but his proceedings among his flock of dependent females are otherwise characterised with much forbearance and gallantry. He may indeed be designated, with strict propriety, a "gentlemanly bird." He never uses his strength to interfere with the wants of his dependants, or to secure for himself a greater share of food. On the contrary, when he discovers any store of grain, or other acceptable supply, he utters a well-known cry which brings all the females about, and he will stand aside, as if enjoying the sight of their repast. The cock indeed displays an unusual amount of intelligence and spirit, whereas the hen has already been justly characterised as a stupid bird, which, in its domestic state, and when free from the maternal cares and duties, simply pursues the daily round of eating and sleeping, without betraying any traces of the natural instincts which must have pertained to it in its wild state. The cock and hen seem to be, of all birds, the oldest companions of man; and our familiarity with them has led to the use of their names, in reference to birds in general, as synonymous with the terms *male* and *female*. They are believed to have been originally introduced into Europe from Persia, though they do not now occur in that country in a wild state. They are still found, however, in their natural state in some of the islands of the Indiàn Ocean; and there the males display the same pugnacity and jealousy of the intrusion of rivals as they have retained in their domesticated state.

The Turkey, with which we are also so familiar in its domestic state, is originally a native of America, where it still abounds, and is therefore a much more recent introduction to the poultry-yard than the domestic cock and hen. It cannot be considered as equal, in intelligence

and sagacity, to the cock; and, indeed, like the duck, the female turkey, in its domestic state, is frequently an indifferent nurse of its young brood, so that the eggs of the turkey are sometimes placed for greater security under the care of a brooding goose. The peculiar cries of pleasure or alarm, and the challenge to combat, of the turkey-cock, however, no less illustrate the varied and expressive language of birds, and show the care with which each species is instructed in its own means of communicating together for all the purposes and requirements of life. It is highly esteemed among our domestic poultry, and though so recently introduced into Europe, is now deemed an indispensable feature in the Christmas feast, and is invariably associated in England with that ancient and popular festival. Though the turkey thrives well in its domestic state, it is a much larger and more beautiful bird when found in its native wilds amid the woods of the American continent. It is there met with in large flocks, which rarely take to the wing unless when compelled to cross a river, or surmount some similar obstruction to their progress. Their singular gobbling, and peculiar mode of drooping their wings, and reddening the fleshy covering of their neck and head when angry, are natural to them in their wild state, and suffice to call their hens, or to proclaim defiance to a rival. They are, however, thoroughly gregarious, and feed together in large flocks, including many males.

Many of the singular cries of birds have been associated by popular fancy with peculiar superstitions, or are naturally suggestive of the feelings with which they are generally linked in the mind. The melancholy or ominous hooting—the boding cry—of the owl; the no less ominous croak of the raven; the harsh, yet sad voice of the peacock; the plaintive love-notes of the wood-pigeon, or the cooing of the dove; the valorous trumpet-notes of the gallant cock, and the foolish hiss of the

goose; all suggest the fancies associated with them by their expression of such ideas, though, for the most part, these are mere arbitrary associations. But the natural language of birds is in reality a means of intelligent communication between them, abundantly suited to their requirements, as our more excellent gift of language corresponds to the demands of reason, and the abstrusest speculations of the intellect.

CHAPTER XIII.

FLOCKS AND HERDS.

THE geographical and local distribution of animals involves many interesting inquiries relative to the creation and natural characteristics of the whole animal kingdom. The facility with which both birds and fishes can move from place to place, apparently with no other limits to the locality they occupy than what their own inclinations and natural instincts may suggest, as well as the annual migrations of many even of our smallest birds, from the temperate both to the frigid and torrid zones, prevent our regarding the localization of either of these classes of living beings with the same interest or curiosity which we attach to the geographical distribution of quadrupeds. The same laws, however, control both. Though many fish migrate in a manner similar to birds, and for like purposes, the various inhabitants of the deep occupy each their own natural locality with fully as much tenacity as quadrupeds or birds. Some occupy the shoals, advancing and receding with the tides, others are found only in deep water, and the habitats of every species are determined by the same reasons, depending on temperature, proper

food, and a means of escape from their predacious foes, which influence the inhabitants of the land. There are, indeed, causes peculiar to the element which marine animals occupy, which modify these variations of locality, and other habits of different species. "The general temperature of the ocean," says Dr. Prout, "differs considerably from that of the land. Owing to this difference of temperature, and to the peculiar mode of subsistence of marine animals, which find their prey chiefly in the waters they inhabit; the distribution of these animals varies much, as compared with the distribution of animals that are entirely terrestrial; particularly within the frigid zone. It is true, indeed, that in all climates, the denizens of peculiar localities, as fresh water species and those that resort to the shallows on the coast, are influenced by the climate nearly as much as land animals: and within the Tropics, this influence extends in some degree even to the species that dwell on the wide ocean. But far to the north, and to the south, such species are influenced in a manner altogether different. Thus the largest of known animals, the *Whale*, and of course those other animals that become its prey, roam through the utmost Polar seas; where on land the intensity of the cold would prevent the existence of any animal whatever. In that climate the whale is enabled to live, solely on account of the greater warmth of the Polar ocean, as has been formerly explained. Among the larger inhabitants of the ocean in tropical climates, may be mentioned the *Shark* tribe; which, in respect of ferocity and voraciousness, may be classed with the tiger, or any kindred species on land. The influence of climate on marine animals is further shown, by the enormous size of many of the tropical shell-fish and mollusca. The colouring of these and also of other productions of the Equatorial seas, often exhibits so much lustre and beauty, as to rival the most splendid of the feathered race. In tem-

perate climates, and from the equal temperature of the sea, even within the frigid zone; it is remarkable that fish, like terrestrial animals, are much disposed to be gregarious. The shoals of *Herring*, *Mackarel*, and other well known visitants of our coast, are familiar examples of the gregarious tendency. The *Salmon* and the *Sturgeon* may be adduced as instances of fish inhabiting chiefly the rivers of the temperate and colder countries. While in the same climates, instead of the magnificent *Pearl oyster* of the Tropics, there appears our common *Oyster*, so diminutive and unsightly, yet so profitable to man."

This adaptation of all living things, whether animal or vegetable, to particular climates, so effectually controls their movements on a large scale, that the transference of any of the natives of the torrid, temperate, or frigid zones to another, almost inevitably leads to their extinction. In combating with these laws of nature which thus control the distribution of animal and vegetable life over the globe, we are in general compelled to resort to the artificial imitation of climate and local features, as in our zoological and botanical gardens and hot-houses. Yet there are important exceptions both in the animal and vegetable kingdoms to this general law of adaptation to a particular climate, designed apparently, for the most part, for the benefit of man. Those species which constitute the most valuable sources of food, and of all the artificial appliances essential to human civilization, appear to be least affected by a change of climate. The chief cereal plants are, indeed, no longer met with in a natural state. They are believed, however, to have been found originally in Central Asia, the earliest seat of the human race, and from thence they have been distributed through the greater part of the old and new world. The same is also the case with the domestic animals; of which the horse, the ox, the sheep, the goat, the hog, and also the dog and cat, some, if not all of which, are found distributed over

nearly every region occupied by man. The different varieties of domestic poultry have been extended in like manner over a considerable portion of the inhabited globe. That this important variation from the general laws affecting the geographical distribution of animals, is not merely the result of the use of such artificial means as man employs for his own ends, is proved beyond doubt by the circumstances attending the introduction of the same animals into the new world. Nearly the whole of the domestic animals of Europe are now spread over the vast continent of America, from Canada to Paraguay, and some of them in the greatest abundance where they are entirely free from domestication or human care. The wild horses, bred from those first introduced by the Spaniards into the new world, now roam over its vast prairies in incredible numbers, and the hogs derived from the like sources have not only proved equally prolific, but they have given rise to new varieties, resulting, in part at least, from the peculiar circumstances of their novel colonization.

The domesticated animals include all those herbivorous and ruminating quadrupeds which constitute nearly the sole wealth of communities while still in a pastoral state, and in all conditions of society form an important source of national wealth and prosperity. The flesh of our cattle and flocks forms an important and most indispensable means of subsistence: the horns of the cow supply requisite materials for the comb-maker, the cutler, the turner, and many other manufacturers; its hair is indispensable to the plasterer, and its hide, under the manipulation of the tanner, currier, shoemaker, pocket-book and trunk maker, the saddler and harness-maker, as well as numerous other manufacturers and mechanics, becomes one of the most valuable of our native raw materials; while even the waste parings of the hide, converted into glue, supply to the painter, gilder, paper-stainer, and

many more industrious labourers, one of the necessary materials for their useful arts. So also with the sheep. Besides the important place which it occupies in supplying our table, its skin is manufactured into parchment, or prepared into the finer leathers which the bookbinder, the shoemaker, and glovemaker require; while, above all, it supplies to us the abundant stores of wool from which so many of our most useful and valuable manufactures are wrought. The chief excellence of the sheep may, indeed, be said to consist in the quality of its wool, and the value of this appears to have been understood from the very earliest time.

So far as appears from the notices we possess of the early history of man, the sheep would appear to have been the first object of his care, and the earliest of domesticated animals. Abel, the son of our first parent, was a keeper of sheep, and offered to God the acceptable typical sacrifice of a lamb of his flock. With Job, Abraham, Lot, Laban, and all the early patriarchs, their chief wealth consisted in their flocks and herds; and in the language of Scripture the white wool is employed as one of the most familiar and striking contrasts to the deep scarlet or crimson of the dyer. The wool of the sheep is subject to great modifications in different countries, and in unusually warm climates it totally disappears, so that in the West Indies, for example, the sheep is very soon found clothed in hair, and bearing considerable resemblance to a fawn, or small doe. The covering of the sheep appears to consist naturally of a mixture of hair and wool, of which the hair is of greatest length, while the wool forms a fine inner coat, giving warmth and protection to the animal. Much, it is found, may be done to modify this, by careful training and protection. Exposed, as we have seen, to the excessive heat of southern latitudes, the wool entirely disappears; but exposure to an excess of cold is also found to be injurious to the

wool, especially if accompanied with neglect and a deficient supply of food. It is, accordingly, an object of careful cultivation by the sheep-farmer, so as, after selecting the breeds best suited to the locality, to subject them to such treatment as is found most calculated to diminish the quantity of hair, and increase and improve the character of the wool. The design of the Creator in providing the animal with this fine under-covering was obviously to protect it from the cold, and it has been accordingly found that, under a careful system of management, the coldness of our climate rather tends to improve the wool. An abundant supply of wholesome nutriment increases it both in length and bulk, and though under exposure to extreme cold it loses somewhat in weight, this is more than compensated for by its increase in length.

There are many varieties in the breeds of sheep; that which is best suited to the Downs of Wiltshire and Sussex being found unsuited to the Highlands of Wales or Scotland, or to the Cheviot and Grampian hills; while a peculiar breed of small short-wooled sheep inhabiting the Shetland Islands, yields the finest wool which Great Britain can produce. This is now extensively used in the manufacture of the better sorts of stockings, knitted woollen shawls, and other light fabrics. Among European breeds, none are more celebrated than the Merino sheep. Its native country is Spain, and its wool is known to have been in general request so early as the commencement of the Christian era. It is found to be peculiarly capable of sustaining without injury a degree of neglect which would greatly deteriorate the wool of other sheep, and it has accordingly been introduced, by degrees, into most countries of Europe, and is now found in numerous flocks in our Australian colonies; from whence a large and valuable stock of wool is annually imported into the mother country.

Among the most characteristic operations of the summer

season, are the washing and shearing of the flocks. The proper season for sheep-shearing is no less clearly marked by nature than that of any other of the farmer's annual harvests. The wool is weak and unfit for spinning before it is full grown; and if left long uncut after it reaches maturity, it rapidly deteriorates, becoming yellow in colour, and growing ragged, felted, and unfit for application to any of the finer purposes of the manufacturer. The season for the wool harvest had, accordingly, its annual festivities from the earliest times. In the life of David, we learn of the festival celebrated by Nabal at the time of sheep-shearing, which was "a feast like the feast of a king." In England, it formed one of the great rural festivals, only inferior to the harvest-home. The shepherd whose flock had yielded the first lamb of the season became king of the feast; a queen was also chosen; and a joyous repast of simple rural dainties, in which the products of the dairy had a prominent share, was followed by sports and the dance. The beauty of the season added no less to the adornments of the festival than to its full enjoyment. The months of June and July, the loveliest period of the year, are those in which the British wool-harvest is gathered in. The trees are then in full leaf; the gayest and finest-scented flowers abound, and nature seems to have spread out the verdant lawn for the sports of the season. This, like most other rural festivals, has nearly fallen into total disuse in England; but still the preparatory sheep-washing remains as indispensable as ever, and furnishes no small amount of boisterous and healthful sport to all engaged in it. This may, indeed, be pronounced the most picturesque, as well as the most jocund of all the pastoral operations of the year. Well do we remember, during a long ramble among the Pentland Hills, in the lovely month of June, stumbling by chance on the sheep-washers, busy in their exciting work, and of our lying at length on the grass,

through the mid-day hours of a bright sunny day, to enjoy the beauty and the joyous hilarity of the scene. A small mountain streamlet trickled down through the valley; and across a narrow gorge, a wall of rough stones and turf had been constructed to dam up the waters, and convert them into a broad pool. On one side of this, a rude sheep-fold had been erected, from which the sheep were brought, one by one, and forced to leap from an abrupt bank into the pool, where a party of lusty youths were in readiness to seize them, and force them to submit to the necessary ablution. Sometimes, however, a sturdy old ram would rebel, and, escaping from the edge of the pool, would afford excellent sport to a group of merry urchins assembled round the brink, whose task there, with the efficient aid of the dogs, was to bring the straggler back to his unwilling purification. Once and again the unwilling straggler, forced at length to take the leap into the pool, would, by a violent and unexpected jerk, carry with him one of his captors, still holding by the horns, floundering into the water; while the hearty mirth of the rustic bystanders served to allay all fears of any danger from this unexpected ducking, under the warm and sunny skies of June.

There seems, indeed, in all the operations of pastoral and agricultural life, an element of joyous sympathy in the realization of cherished hopes, such as is only rarely experienced in other achievements of human enterprise. The Divine promise to man, which engages that seedtime and harvest, cold and heat, summer and winter, shall not cease; and which points to the bow, as the covenant-sign of that Divine pledge, justifies, in a peculiar manner, this rejoicing over the gifts of a bountiful providence. The simplicity of the pastoral life, and the pleasant associations with the keeper of flocks, add to the freshness of that joyous hilarity wont to characterize the annual triumphs of the shepherd and the husband-

man, in contradistinction to the more studied displays, by means of which the dwellers in crowded cities manifest their joy. The annual and stated recurrence of these seasons in which the husbandman gathers in, is calculated to enlist the sympathy of the rustic community in a way unknown to dwellers in cities. They are the termination and return for months of anxious hope and unwearied care, during which much of the result depended on sources of influence beyond their control. Piety, and the devout sense of dependence on the over-ruling care of the great God and Father of all, are in no degree especially confined to the country. In dark and crowded lanes and pent-up streets, no less than on the open plains, and under the broad, serene canopy of heaven, God finds sincere and pious worshippers; yet we are not without some reason to justify the feeling which led the Christian poet to exclaim,—

> "God made the country, and man made the town;
> What wonder, then, that health and virtue, gifts
> That can alone make sweet the bitter draught
> That life holds out to all, should most abound,
> And least be threatened in the fields and groves?"

CHAPTER XIV.

CHARACTERISTICS OF THE SEASON.

The peculiar characteristics of summer, wherein its chief charm, and all its diversified beauties, mainly consist, may be aptly expressed in one word—*maturity*. It is the manhood of nature. The flowers are clustering in their richest bloom; the trees are thickly covered with their verdant foliage; earth, sea and sky, seem to repose in their most graceful and pleasing aspects; and the sea-

son no longer, as in that of spring, derives its attractions from the pleasure of contrast, and the delightful anticipations towards which hope reaches forth; but it seems in itself complete, and confers the sense of enjoyment which all experience who participate in its fully-developed beauties, from a sense of actual attainment and repose in its perfections. All nature appears to rejoice in the maturity of the season, and the universal harmony and beauty which it has educed. In our own temperate climate, the bright blue sky is fleeced by an ever-varying curtain of airy clouds, changing from the soft grey of dawn to the crimson glow of the gorgeous sunset. The evening twilight succeeds, fading away slowly into darkness, and then the glories of night's azure vault steal forth, one by one, until her thousand lamps light up the sky, and the thoughtful observer forgets the largeness of his interest in the maturity of earth's seasons, in contemplating the boundlessness of that universe of God wherein it occupies so small a place.

In the warmth of summer, it is difficult for the mind to escape the impression of a universal diffusion of joy throughout nature. The meadows are enamelled with flowers lovely and diversified in hue; every shrub and tree has assumed its fullest beauty; and all animated creation appears to share in pleasurable sympathy with such inanimate abundance and completeness. The luxuriant clover-field seems to offer to the grazing flocks and herds an inexhaustible supply; while the bee and the butterfly, and a thousand other insects, flutter in the sunbeams, sipping from each blossom the rich nectar so abundantly provided for their wants. The hare and the partridge start from field and brake, at the sound of the wanderer's footsteps; the trout startles him for a moment with a pleasant surprise, leaping from the quiet pool; and the groves are filled with the feathered songsters, rejoicing in the abundance of the genial season, and exchang-

ing the happy, yet anxious cares of spring, for the unfettered enjoyment of the fulness around.

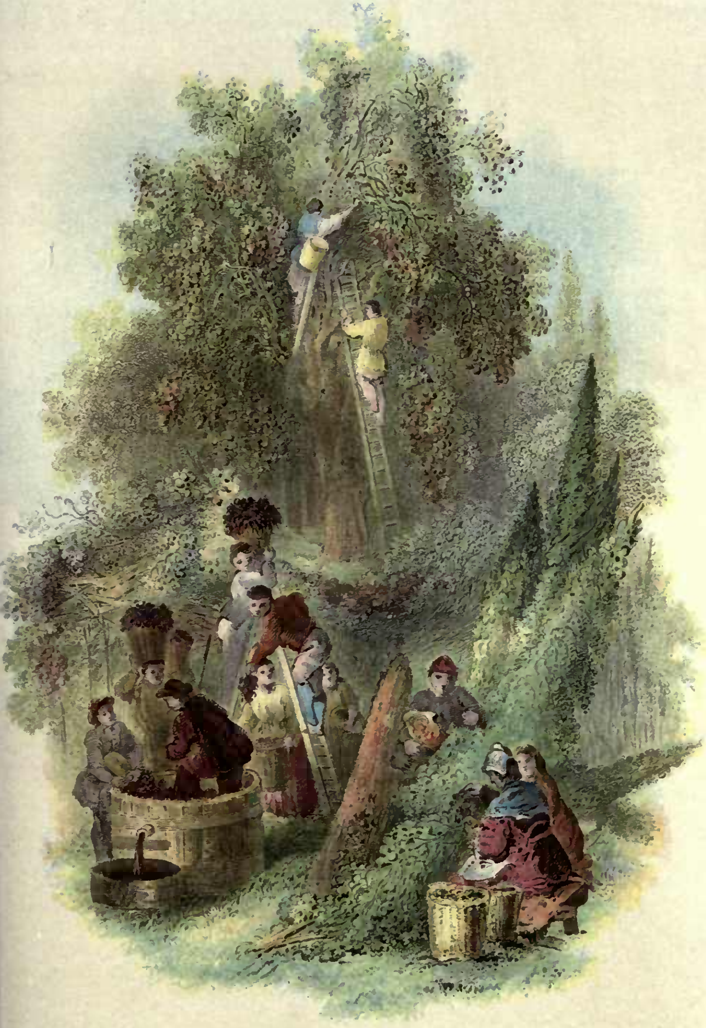
While enjoying the pleasures of rural scenery under the bright glow of a summer sky, we experience an added feeling of delight from the sense of repose which appears to belong to the season. It seems as if nature had reached her culminating point, and were content to rest for a while in the calm enjoyment of her beautiful maturity. The anxious labours of the spring are all past, and the more joyous toils of the harvest are yet to come, while its pleasant cares seem to be anticipated in the fragrant summer-harvest of the hay-makers. The occupations of the hay-field seem so delightfully to harmonize with all the other characteristics of this beautiful season, that they are invariably associated with ideas of enjoyment. The graceful and manly stride of the mower with the long sweep of his scythe,—the attendant maidens busy with their rakes, turning and gathering it,—the peculiar fragrance with which it fills the air,—and the sounds of mirth and glee which seem invariably to accompany the building of the hay-cock, or the loading of the carts, and the final removal of it to the barn-yard,—all fill the mind with a sense of pleasure. The soft breezes, freighted with sweet odours, come stealing through the trees with a delightful sense of refreshing coolness and invigorating health. Even the summer rain falls pleasantly, cooling the over-heated air, and refreshing the parched soil. The sense of enjoyment conveyed in its gentle, invigorating moisture, appears to have been experienced from the earliest times, and is beautifully indicated in the Scripture simile of the Divine influences, as manifested in Christ: "He shall come down like rain upon the mown grass; as showers that water the earth." And still earlier, in the triumphant song of the Hebrew Lawgiver: "My doctrine shall drop as the rain, my speech shall distil as the dew; as the

small rain upon the tender herb, and as the showers upon the grass." The dwellers in cities lose much in their total exclusion from all these genial aspects of nature. Within the crowded city, the summer rain is simply a source of discomfort; or, at best, it only appears of value in so far as it may serve to lay the dust, which it speedily converts into unsightly mud. But under the green tree, and surrounded by the meadow and corn field, it is as welcome and as beautiful as the sunshine; and, after long drought, is the harbinger of new beauties, and of a richer fragrance in mead and garden. All nature appears to be refreshed; a sound, as of renewed vigour, seems audible throughout nature, and the song-birds sing in the groves with a sweeter note, while the sun, bursting through the clouds, and gilding the whole landscape with his refulgence, appears literally to smile with additional brightness on the reinvigorated scene. David, "the anointed of the Lord, and the sweet psalmist of Israel," recalls the beauty of nature under such sweet summer aspects, when singing with prophetic inspiration the praises of "the Rock of Israel:"—"He shall be as the light of the morning when the sun riseth, even a morning without clouds; as the tender grass springing out of the earth by clear shining after rain."

> "The rolling year
> Is full of thee. Forth in the pleasing spring
> Thy beauty walks, thy tenderness and love;
> Wide flush the fields; the softening air is balm;
> Echo the mountains round; the forest smiles;
> And every sense, and every heart is joy.
> Then comes thy glory in the summer months,
> With light and heat refulgent. Then thy sun
> Shoots full perfection through the swelling year;
> And oft thy voice in dreadful thunder speaks;
> And oft at dawn, deep noon, or falling eve,
> By brooks and groves, in hollow-whispering gales."

We have already traced in the characteristics of spring the evidences of Divine benevolence, and unbounded

goodness in the works of creation; and the characteristics of the season of maturity no less clearly lead us to the same conclusion. The simple end in view appears to be the provision of food, the maturing of plants and animals, and the development of seed for the reproduction of vegetable life in the following spring: but, besides these essential ends, we find fragrance and beauty provided in every leaf and flower, in every insect and bird that flits about or carols amid the green leaves. The lessons of summer will no more than those of spring reconcile all difficulties, or illuminate to us what is mysterious, obscure, or incomprehensible in the ordering of nature, and the dealings of God with man, but in so far as their lessons are clearly expressed, they point with no less distinctness to the same conclusions, and show us that the God of nature is a God of love.



AUTUMN.

Apple. Grape & Hop Gathering

AUTUMN.

Season of mists and mellow fruitfulness,
  Close bosom-friend of the maturing sun;
Conspiring with him how to load and bless
  With fruit the vines that round the thatch-eaves run;
To bend with apples the mossed cottage trees,
  And fill all fruit with ripeness to the core;
To swell the gourd, and plump the hazel shells
  With a sweet kernel, to set budding more,
And still more, later flowers for the bees,
Until they think warm days will never cease,
For summer has o'erbrimmed their clammy cells.

KEATS.

CHAPTER I.

THE REALIZATION.

THE characteristic feeling of spring is hope, that of summer may no less justly be said to be enjoyment, while that of the season we are now to consider is the realization of the hopes which the germs of spring gave birth to. It is the time of harvest, when the ripened fruits succeed to the flowers, and man enters on his reward for the labours of the past. The year is now on the decline, but the transition is gently and gradually developed. The sun is visibly shortening his course through the heavens, the day is yielding to the night, and the intense heat of June and July begins to give place to a milder warmth, with chiller mornings and evenings, which, in our climate, give early premonition of the coming winter. There is no room, however, for any thought of the future in this busiest season of the year. Vegetation still appears in luxuriant beauty. The gathering of the hay crop into the barn-

yard has made way for a new growth of young clover, diversifying the landscape with its rich green, variegated with its fragrant blossom, intermingled with the numerous tints of the later blossoming flowers. The meadows still abound with a profusion of succulent herbage, and the flocks and herds luxuriate in the tender clover springing up in the new mown fields. Summer, as we have seen, has its harvest. The rich and fragrant meadow crop is then gathered in and stacked in the barn-yard. Many of the flowers, also, which give so peculiar and varied a character of beauty to the summer landscape, are then ripening and casting their seeds, and, throughout the greater part of the season, a welcome succession of vegetables and fruits are attaining their full ripeness, and furnishing the gardener with valued stores. While the summer is yet in its prime, the strawberry plant, and the gooseberry and currant bushes, have yielded their welcome fruits to add to the pleasures of the season, and are already past ere the harvest sets in. Autumn, however, is the season in which all the fruits, vegetables, and grains, come to maturity which are capable of being stored for future use, and form the most essential means of subsistence to man. In this, indeed, we perceive one of those evidences of that Divine wisdom by which the whole course of the seasons is regulated. The provision for the winter is to be gathered immediately before the season of sterility and repose sets in, and the fruits of the earth are brought to perfection at the very time when the succeeding chill of winter will preserve their germinating principle of vitality inactive, and render them the more suited to be gathered into store-house and barn. We see the same beneficence manifested in the provision for the wants of all the lower animals. The mayflower which adorned the hawthorn with its richly scented blossoms throughout the early summer has been succeeded by the haw, the red clusters of which hang in every hedge-row, and cover the branches

of the hawthorn tree; while, as the season draws to a close, the thick blossoms of the wild dog-rose are disappearing to make way for the crimson hips, on which our native songsters feed with such relish and delight.

It has been remarked of autumn, with considerable justice, that it partakes to some extent of the characteristics of all the other seasons, and shares in all the beauties of the year. It has its flowers as well as the summer, though in less profusion and with diminished fragrance; and these also rapidly hasten to develope the seeds and fruits which more strictly pertain to the season of harvest. It is indeed in all respects the period of realization, and the end towards which the seasons point; for the frosts, and sleep, and deadness of winter, lend also their aid towards the golden harvests of autumn, even as the slumber of infancy aids no less than the nourishment drawn from its mother's breast, to foster it, and slowly bring it onward towards maturity.

An intelligent Christian minister has made the subject of the harvest, and its many associations, the basis of some very interesting and apposite reflections, under the title of "A Harvest Tract." The allusions to pastoral and agricultural labours in the Old Testament are indeed calculated to awaken in all minds a lively interest, as links connecting those old times with our own; while, in the New Testament, the harvest is made the type of the most solemn and momentous of all coming events relating to man. "From the time of Adam, (who was himself the first harvest reaper,) the Bible gives many notices of harvest time. We read of Cain being a tiller of the ground, and bringing his first harvest fruits as an offering to the Lord; again we read of Noah becoming a husbandman, or man of the ground, gathering, doubtless, rich crops from the renewed face of the earth; next, of Ruth, following her kinsman's reapers during the barley harvest in

one of the valleys of Bethlehem; two hundred years later, we read of the prophet Samuel, when he was bent with age, at the time of wheat harvest, calling down thunder and rain from heaven; and of another sultry harvest day when king David was in the cave of Adullam, with the host of the Philistines encamped in the valley below him, and when longing to get his thirst quenched from a favourite well at Bethlehem, three sturdy warriors made their way, at the risk of their life, through the enemies' camp, and brought him in their hands the cooling draught; finally, we read of the Lord Jesus Christ himself, while on earth, looking around on the glories of the harvest season, saying to his disciples: Behold! lift up your eyes, and look on the fields, for they are white already to harvest."

The author of the above tract thus directs attention to the antiquity of harvest rites: "I should like to say a few words at the outset, on the history of the harvest. People often feel a deep interest in things that are old and of long standing. The harvest is as old as the world! There are many new things now-a-days which men of former ages knew nothing about. Our railways, our steam-boats, our telegraphs, our machinery, our art of printing, are all modern inventions. They are but of yesterday. Not so our harvests. These waved on our earth long before the flood. The sun in heaven has looked down on nearly six thousand of them.

"Moreover, in olden times, and in these eastern countries, they seem, in many respects, to have been the same as ours. We read of wheat harvest, and barley harvest. We read of sickles, and binders, and reapers, and gleaners.

"The world has altered its usages much in many other things, but it has altered little in this. A harvest field now, is very much a picture of what a harvest field must have been as it appeared to the patriarchs.

"But is this all? No! The most interesting fact re-

garding the harvest remains to be told. It is a grant connected with the Covenant of Grace!

"One summer evening after the deluge, Noah was seen standing by an altar of burnt-offering. No sooner did the blood of slain animals stream over its sides, and the column of smoke from the blazing sacrifices reach the sky, than a rainbow was observed to span the heavens. God pointed the aged worshipper to that 'bow in the cloud.' He told him it was the sign and seal of a new covenant grant. In that grant the harvest has a foremost place:—'While the earth remaineth, seed-time and harvest, and cold and heat, and summer and winter, and day and night, shall not cease.'"

We are thus taught to look upon the annual harvests as the fulfilment of a covenant promise, pledged to man with all the solemnity and earnestness which we can readily conceive the Divine condescension capable of yielding to man. Yet the occasion was not unworthy of it. We learn from the sacred narrative of the failure of the harvests on a certain occasion in Egypt, and the vast consequences which flowed from it, not only to that kingdom, but to all the surrounding nations; and still more impressively, because practically, we have learned in recent years how greatly the whole institutions of a nation may be shaken, even by a very partial interruption of annual fruits of this season of ingathering. Only within the present century a foreign root, the potato, was largely introduced into general use. Among the wealthier and middle classes it has formed, along with bread, the invariable accompaniment of animal food, while among the larger portion of the agricultural population, especially in the Scottish Highlands and in Ireland, it has gradually become the main source of their subsistence. Suddenly, however, a blight fell on this useful plant, the crop completely failed; hundreds of thousands of the population were deprived of nearly their sole means of

subsistence. Famine and disease rapidly spread throughout the land. The wealthier classes contributed immense sums to alleviate such dire sufferings; government came forward with the public funds, and foreign nations freighted ships with supplies to meet the pressing wants of the famishing populace. Yet, notwithstanding all these extraordinary exertions to meet the failure of so limited a branch of our annual harvests, thousands of the people died, thousands more emigrated, and for the first time during the present century, the census has exhibited a positive diminution of the population of one important section of the united kingdom; while the political and social changes springing from it, promise to effect a gradual revolution on the entire condition of Ireland. It was, therefore, a promise well suited to the advent of that new order of things which succeeded the deluge, that seed-time and harvest shall not cease. It is no less worthy to be the occasion of such joy and exultation as usually attends the reapings of a full harvest, and the gathering in of the abundant stores of the cultivated fields. "The Bible takes a harvest field to describe the joy of salvation:—'They joy before thee according to the joy in harvest.'

"Harvest, indeed, is a joyous season, notwithstanding all its toils. It was so in olden times; it is so still. The young hail it as a joyous holiday. The older hail it as a gladsome relaxation from other labours. The master rejoices when he sees the result of a year's anxiety about to be safely gathered in. The servant who has had the burden of tillage, and sowing, and constant watching, views with an honest pride and joy the fulfilment of his task.

"We like to hear innocent merriment and happiness in a harvest field. All nature itself seems in a joyous mood. To use again the striking words of the Psalmist, the fields seem to be 'clapping their hands.' The little

hills are rejoicing on every side. It would seem strange if man were sad and melancholy in the midst of all this joyous scene!

"Reader! the Bible takes you into the midst of such a gladsome harvest field, and whispers in your ear: Such is a picture of true religion! The believer is a happy man. There is no true happiness but in the service of God. Many would have you to believe it is all the reverse—that the religious are unhappy, always gloomy, and sad, and dull! Ask every true Christian, and you will have but one reply,—'I reap in joy.' 'Thou hast put gladness in my heart, more than in the time that their corn and their wine increased.'"

No less beautiful and apposite is the application of the harvest joy, as a type of that of admission to heaven. "In due season," says the Apostle Paul, "we shall reap if we faint not." While still more strikingly the Psalmist exclaims:—"He that goeth forth weeping, bearing precious seed, shall doubtless come again with rejoicing, bringing his sheaves with him." In our own day many of the pleasant and graceful festivities with which the various seasons were welcomed, have fallen into disuse. The farmer, and the landed proprietor, no longer resemble the old patriarchs surrounded by their own families and dependents. The very processes of agriculture are undergoing a rapid chang

The advancing intelligence, mechanical ingenuity, and engineering skill of the age, have all been brought to bear on the labours of the farmer, while social and political changes have no less affected his position. The steam-engine has superseded the old thrashing and winnowing processes, and appears now to be on the eve of supplanting the reaping hooks,—old almost as the race of man. Amid such changes we cannot wonder that the old sports of May-day, and the rejoicings, and the garlands, and the dance of the harvest home, should be

giving place to more modern rites, nor need we vainly mourn

> "How all the old honour has from Christmas gone,
> Or gone, or dwindled down to some odd games
> In some odd nooks."

Fashions, however venerable and revered, must change, but the "joy of harvest" still remains in all its essential attributes the same, though it finds its chief exponent now in the agricultural reports of the newspapers, and the greetings of the successful farmer in the grange and the market-place.

CHAPTER II.

AUTUMNAL VEGETATION.

THOUGH the period of greatest annual heat is to be looked for in the season of summer, yet it is by no means uncommon in the earlier part of autumn to experience a continuance of dry, warm weather, little inferior to that of midsummer, except in the visible diminution in the length of the day, and the increasing chill of the longer night. The sun is gradually withdrawing his vivifying powers, but the accumulated heat of the earlier months is still powerful, and a continuance of dry, sunny weather, serves to prolong it into the season of full harvest. We have already noticed the characteristic of autumn, that throughout its transition from the heat of summer to the cold of winter, it presents a succession of weather akin to all the other seasons, though in an inverse order, adapted to its position in the successive seasons of the year. First comes August, still warm and bright. The trees are in full foliage, and the later blossoming ones, such as the sweetly scented lime, are then in flower, and fill the air with an unwonted fragrance. The flowers

also, though now rapidly diminishing in the number and variety of their tints, are still abundant, and receive accessions from the later ones peculiar to the autumnal season. The sky also has a brilliancy and calm beauty, peculiarly charming to the student of nature, and at no period of the year are the sunsets so varied and beautiful as in the early part of autumn. To this succeeds the spring-like weather of September, possessing much of the fickleness of spring, without the hopeful anticipations of a coming summer, which give to the latter so much of their peculiar charm. The sky of September assumes many of the characteristics familiar to the student of nature in spring. Sudden gusts of wind are accompanied by the rapid change of the clouds: piled up occasionally in huge masses, whose beautiful forms change as they are tinted along their edges by the sun; while frequently a light lower stratŭm of thin white cloud scuds along under the influence of lower currents of the atmosphere, and significantly indicates the unsettled character of the period. The mornings and evenings, also, become unusually cold; and even when the mid-day sun is found oppressively hot, it remains chill in the shade, and the dew lies thick under the shelter of the trees. To this succeeds the sharp, bracing, wintry October. The aspect of nature is entirely changed. Already the trees are looking bare; the crisp hoar frost sparkles beneath the feet in our morning walk; its finest days are clear, but cold; and these are frequently interrupted by fogs, and sudden gales, or by a change to milder weather, accompanied with gloomy clouds and rain. Thus does autumn seem to present us with an inverted picture of all the other seasons, yet it has also a character altogether peculiar to itself, and presents nature to us under aspects distinct from all that we have considered in the previous months of the year.

The vegetation of autumn, though characterized by

a diminution both in the variety and profusion of the flowers, presents peculiar beauties of its own, not less charming to the thoughtful mind, and affording attractions for the eye of the artist seldom equalled in the earlier months of the year. Nature seems then to present a sober, matronly aspect, differing in all its associations from the light and gay beauties of the variable yet hopeful spring, but well suited to the transitional period between the mature charms of summer and the desolate sleep of the wintry months. Though summer is the peculiar season of flowers, and autumn of fruits, yet numerous plants reserve their flowers for the latter season, and it is only by a very gradual and gentle transition that we pass onward from month to month, and from season to season, throughout the year. " Most plants, indeed, have some peculiar function adapted to each period of the year, that is, of the now existing year. The sap ascends with extraordinary copiousness at two seasons, in the spring and in the autumn, especially the former. The opening of the leaves and the opening of the flowers of the same plants are so constant to their times (their *appointed* times, as we are naturally led to call them), that such occurrences might be taken as indications of the times of the year. It has been proposed in this way to select a series of botanical facts which should form a calendar; and this has been termed a *calendar of Flora*. Thus, if we consider the time of putting forth leaves, the honeysuckle protrudes them in the month of January; the gooseberry, currant, and elder, in the end of February, or beginning of March; the willow, elm, and lime-tree in April; the oak and ash, which are always the latest among trees, in the beginning or towards the middle of May. In the same manner the flowering has its regular time: the mezereon and snow-drop push forth their flowers in February; the primrose in the month of March; the cowslip in April; the great mass of plants in May and

June; many in July, August and September; some not till the month of October, as the meadow saffron; and some not till the approach and arrival of winter, as the laurustinus and arbutus."

Among trees, no less than among flowers, this succession is apparent. The pale green of the lime-tree gladdens the eye while the sharp frosts of the early spring are reminding us how recently we have emerged from the season of nature's sleep; yet it is one of the very latest of the whole grove to put forth its blossom, and in the latter part of August and the beginning of September, when the flowers are rapidly running to seed, the bees may be seen hovering all day long about its richly scented blossoms, and mounting to the highest branches in search of the fragrant nectar. The horse-chesnut, on the contrary, one of the most beautiful of all our flowering trees, is also one of the earliest, putting forth its rich cone of blossoms in the early months of the year, while its graceful, though valueless fruit, adorns the forest and park in the autumn. The beech again, one of the most characteristic and beautiful of all our forest trees, bears a peculiarly prominent share in the hues which mark the change of nature's robe in autumn, before she throws it off, preparatory to the weaving of a new dress for another season; and, with the oak, may be selected as the predominating feature in English woodland scenery.

No feature of our native landscape strikes the eye of the foreigner as more remarkable or attractive than the noble park scenery which so well assorts with the historic associations of our oldest ennobled families, and of our royal domains. "The immediate neighbourhood of Windsor Great Park," says Jesse, in his Scenes of Country Life, "is rich in varied woodland scenery. There are not only fine thriving oaks, throwing out their gigantic arms, but sturdy pollards without end, which seem to have set time, and seasons, and decay, at defiance. They

are gnarled and knotted, twisted and distorted, yet at the same time vigorous and sound at heart, putting one in mind of a weather-beaten old sailor whose limbs are firm and his body healthy, although his hair is grey and his face seamed with wrinkles. The beeches, too, may be seen of all ages and sizes, picturesque and beautiful in their decay, but while in full vigour and dotted with their sparkling leaves, they are the richest ornament of the wood. The holly loves to nestle under the shelter of its graceful pendulous branches, affording a contrast to its smooth white trunk, on which here and there some pretty lichen may be seen, as if placed there on purpose by the hand of nature to decorate her favourite tree. I love a beech at all seasons of the year. In the early spring it seems not only the peculiar resort of the throstle, 'that Attic songster,' and from its topmost branches we hear

> 'that sprightly wildness in its notes,
> Which clear and vigorous warbles from the beech,'

but its soft green leaves burst forth, covered with a silvery down, and nothing then can be more delicate than their hue, or more refreshing to the eye.

"In the summer, its foliage assumes another character, but still a beautiful one. Its leaves are indeed green, but not of that delicate green we see in the spring. A slight tinge of brown may be perceived along the margin of the leaf, which is otherwise smooth and sparkling. The large red fungus may be seen under its shade, while the rough husks of the mast of former years are thickly scattered about. Here and there are small patches of fern, and round the trunk the ground is covered with the softest moss. Here

> 'At ease reclined in rustic state,'

the squirrel's airy bounds may be seen, and the screaming jay may be heard. Here, also,

> 'Midst gloomy shades, in warbles clear,
> Wild nature's sweetest notes we hear.'

" A black-bird, with its orange bill, fearless of danger, approaches the spot, and then retreats uttering its note of alarm. The green wood-pecker may be heard tapping the loose bark of some decaying tree, and then taking its jerking flight to another, filling the wood with its peculiar wild-cry, which, Mr. White says, seems as if it was laughing at all the world. Nor must the cuckoo be forgotten in this description of woodland scenery. Its hollow note is responded to by that of another, sometimes in rapid succession, till the sounds approach near and more near, and then sudden silence ensues. It is pleasing to hear these unvarying notes. They are listened to with delight by every lover of nature, and there are few birds which would be more missed in rural retreats.

'The merry cuckoo, messenger of spring,'

is hailed on his first arrival as the harbinger of fine weather by every peasant in the country. Shakspeare calls it 'the plain-song cuckoo,' but its notes vary according to the season of the year.

" While seated on the spot I have described, it is pleasant to watch the actions of a squirrel. One may sometimes be seen bounding from branch to branch, and then descending to the ground, when it will sit on its hind legs, look around, and then wash its face with its fore-paws. All its actions are graceful. On being disturbed, it hurries up a neighbouring tree, gets on the side opposite to the beholder, and may soon be seen on the topmost branches, except when it hides itself in some secure retreat, or takes refuge in its *drey*, from which it peeps with a mixture of curiosity and alarm. Mr. Bowles prettily describes it,

'with ears erect,
The squirrel seems to hark! and then to dance,
With conscious tail aloft, and twinkling feet,
Nimbler, from bough to bough.'

" But it is time to attempt a description of the appearance and foliage of the beech in autumn. I have observed

that its rich and golden hues, at this period of the year, depend very much on the soil in which it grows. In chalky soils, in which the beech delights, nothing can be more beautiful than its autumnal foliage. This is best seen when the tree flourishes on some precipitous bank, its roots watered by a meandering rill, while some of them fix themselves in the fissures of the chalky rock; when they appear above the ground, with all their various contortions, they are covered with moss, affording a delightful seat for the traveller. Here mixed with the duller foliage of the oak, whose

> 'thick branches stretch,
> A broader, browner shade,'

the beech may be seen in all its beauty, especially when a setting sun flings bright departing rays on its topmost branches. Nothing can then exceed the lustre of its golden canopy. It is a sight which Gilbert White delighted in, and which he could best describe. The song of birds is now hushed, and if anything disturbs the silence, it is the occasional fall of the beech-nut, as the thoughtful squirrel attempts to secure it for his winter hoard.

"Dear, lovely nature! Often have I courted your delightful shades far from the haunts of men, my heart expanding, I trust, with love and gratitude to Him, who has afforded me so many objects for contemplation and enjoyment. Often have I thought while reclining where

> 'the moss-grown beech
> O'er canopies the glade,'

what a happy world this would be, if a sincere love of the great Creator kept pace with those kindly feelings, which we are instructed to show to each other. Our angry and sordid passions would be lulled, and peace, harmony, and good-will to each other might then abound in this world, instead of so much sin and misery.

" Many lessons might we learn from the objects which surround us, and few more important than that of showing mercy and kindness to the animal creation,—remembering that everything was not only made by, but is under the peculiar care of our common Father. One of our poets, imbued with this feeling, has thus delightfully written :

'The tribes of woodland warblers recite
The praise of Him, who ere He form'd their lord
Their voices tun'd to transport, wing'd their flight,
And bade them call for nurture, and receive:
And lo! they call; the blackbird and the thrush,
The woodlark and the red-breast jointly call;
He hears, and feeds their feathered families;
He feeds his sweet musicians—nor neglects
Th' invoking ravens in the greenwood wide;
And tho' their throats' coarse rattling hurt the ear,
They mean it all for music; thanks and praise
They mean, and leave ingratitude to man.' " *

Autumn, however, holds all its peculiar characteristics in relation to the harvest, whether destined to be reaped by man, or amid untravelled wilds to minister to the wants of thousands of living creatures dependent on the great Father, and to secure the renewal of the vegetable kingdom, and the restoration of the annual floral garment of spring. We are apt to look upon the familiar changes which autumn effects on the vegetable kingdom as little else than the commencement of withering and decay, preparatory to the death-sleep of winter; such, however, is by no means the case. While the earlier weeks of autumn retain nearly all the brightness and warmth of summer, and the temperature has scarcely begun to decrease, the remarkable physiological change in the condition of plants has begun, on which the peculiar characteristics of autumnal vegetation depend. The reproductive instincts and duties, as we have seen, regulate insect and animal life, and so also they occupy an im-

* Jesse's Country Life, p. 22.

portant place in the economy of vegetable life. No sooner does the sap rise in the plant, with the first genial influences of spring, than it begins to put forth the buds from whence are gradually and successively developed the leaf, flower-bud, the full flower, and those seed-vessels or fruits, by means of which the continuance and multiplication of the species are provided for. The final work of the plant, therefore, and the direct end of its being, apart from the further uses to which its products are to be economically applied, appear to be the maturing and perfecting of the seed; and for this purpose, a change in the circulation of the life-sap becomes indispensable, as the fruit approaches towards maturity. The seed-vessel having been fully developed, a gradual diminution of the flow of sap from the root takes place, slowly arresting the further progress of vegetation; and so well aware are practical gardeners of the important influence this exercises in ripening the fruit, that they are accustomed in certain cases to induce the same action artificially by stripping fruit-trees of their leaves, and thus, by checking the flow of the sap, they accelerate the ripening of the fruit. Precisely the same change is seen to take place on the ripening grain. While it is still enlarging and filling, and drawing the needful elements of growth from the soil, the stalk remains green and succulent, and the ear soft; but no sooner has it attained its full size, than the flow of sap from the roots begins to diminish, and at length entirely ceases; the leaf shrivels, the stalk becomes dry and hard, and the pale green colour of the plant rapidly gives place to the golden hue of the autumnal grain.

This class of changes, it is evident, must be regarded as something entirely different from the mere arrestment of vegetation, such as may be occasionally witnessed owing to an unusually early winter abruptly setting in. It is obviously the manifestation of a law no less efficaci-

ous than those which we have seen predominating in the earlier seed-time. It is the last change by means of which the object of creation is accomplished; and, like the diminished energies, and the inclination for inaction and repose, which accompany the declining years of man, it is made a preparatory stage for the coming winter-time, in which all active vitality must cease.

CHAPTER III.

THE FALL OF THE LEAF.

We all do fade as a leaf! is the touching and most truthful language of Scripture; and it is scarcely possible to detach from the characteristics of the autumnal season, the solemn and subdued sense of the last change which precedes the death-sleep of nature. We admire the peculiar beauties of autumn, with feelings altogether different from those with which we watch the progress of spring. On the one, we look with a sense of lively pleasure and joyous sympathy, akin to that with which we gaze on a beautiful and lively child; while we regard the other with much the same feelings with which we look on the silvery hairs and enfeebled step of the hale old man, still noble in decay. His grey hairs are a crown of glory, and claim from us a reverence willingly rendered; and with like feelings we yield our admiration to the beautifully varied tints, which, towards the close of autumn, work so wondrous a change on our woods and groves, preparatory to the winter stage of nature's repose, which precedes, and prepares for the annual resurrection. First, in the beginning of autumn, the sap rises profusely and rapidly, as in the most vigorous period of the spring season, in order to supply the needful stores for the full de-

velopment of seeds and fruits. The elements of future resuscitation and vigour are in like manner provided for. The leaf and flower-bud which appear to burst forth as the offspring of the reviving spring, are in reality the children of a previous season. They are now formed, and carefully wrapped up in the needful swaddling bands to guard them against the winter's frosts; and the labours of the year having been crowned, the sap begins to flow downward through the inner integuments of the bark, the leaves also begin to assume the tints of autumn, and soon the gusts of wind are strewing the lawn and forest with the foliage which has clothed the landscape throughout previous seasons with such peculiar beauty. This, however, is no mere casting away of a useless member whose purposes have been accomplished. Nature, as we have already seen, is not a mere continuous cycle of birth, maturity, and decay; but rather a constant birth of old elements in new forms. The leaf having been eliminated by the sap drawn from the parent soil, acts as the lungs of the plant, receiving and rendering to it the carefully selected gases which are required for its healthful growth, and this important function fulfilled, it is dropped in order that it may mingle with the parent earth, restoring its waste, and repairing its exhaustion, so as to enrich it for the demands of future years.

The change, however, by which the branches of the forest are stripped, and left like naked skeletons, exposed to the blast, is a gradual one, and attended in its progress by much that is beautiful. The rich ripe fruits, and the lovely autumnal flowers, lend a peculiar charm to the landscape over which the breath of autumn is spreading the sombre russet tints of the matured foliage.

> "As yet the blue-bells linger on the sod
> That copes the sheepfold ring; and in the woods
> A second blow of many flowers appears,
> Flowers faintly tinged, and breathing no perfume.
> But fruits, not blossoms, form the woodland wreath

That circles Autumn's brow: the ruddy haws
Now clothe the half-leafed thorn: the bramble bends
Beneath its jetty load; the hazel hangs
With auburn branches, dipping in the stream
That sweeps along, and threatens to o'erflow
The leaf-strewn banks;—Oft statue-like, I gaze,
In vacancy of thought, upon that stream,
And chase, with dreaming eye, the eddying foam,
Or rowan's clustered branch, or harvest sheaf,
Borne rapidly down the dizzying flood."

Some interesting and valuable reflections are presented to us by the fall of the leaf. According to the fanciful language by which we speak of the "bare skeletons" of the forest, or the "naked trees," exposed to winter's pitiless blasts, it may seem as if the tree were stript of its clothing when most in need of it. Here, however, we perceive one of the unmistakeable evidences of a wise adaptation by the Creator to the necessities of the season. During the sudden gales occasionally experienced in early autumn, while the trees are still in full blossom, we see on a limited scale the effects which would be produced on the park and forest by the winter's storms, were the trees to encounter them clad in the full foliage of summer. The former rarely pass over without strewing the lawn with broken branches, and tearing up some tall and vigorous tree by the roots, while the more enduring storms of winter sweep unresisted through the naked branches, and leave the trees uninjured by their violence.

Different causes have been assigned by the vegetable physiologist for the change and fall of the leaf. Some ascribe it to an inequality of growth between the stem and petiole of the leaf throughout the period of vegetation, or to the mere drying and hardening of the cellular tissue at the point of junction, consequent on the maturing of the leaf and the diminishing flow of the sap; others refer it to the formation of the new bud; but whatever be the immediate cause, the process is manifestly consistent with the operations of nature throughout the whole process of

vegetation, wherein we see leaves, flowers, seed-vessels, and finally the whole season's foliage, wither, and fall so soon as their functions are fulfilled. Wisdom is exhibited under varying forms of manifestation, in every aspect of nature. The animal is prepared for its state of hybernation by an accumulation of fat which clothes it, and provides a supply to be slowly absorbed and applied to the maintenance of its slumbering vitality. The tree, on the contrary, is stript of its whole external clothing, and sinks into its wintry state of torpidity, with its naked branches spread exposed to the blast. It may then be taken from its native soil and transplanted to any distance without injury, if its roots remain unharmed, and to all appearance the vital powers of nature are then entirely suspended. Yet it is not so. The autumn bud continues throughout the winter safely protected from the frosts which would blight the expanded leaf; and the lethargy of the plant is no more than a healthful sleep, from which the genial voice of spring will awaken it to renewed life and vigour.

CHAPTER IV.

CEREAL PLANTS.

No change of vegetable nature is so intimately associated in all our thoughts with the season of autumn as the ripening and maturity of the golden grain. Yet while summer has its autumn-like duties of harvesting, in the ripening meadow and hay-field, so also autumn borrows of the spring, and commits some of the most important seed to the soil preparatory to the harvest of the succeeding year. No sooner are the ingathering labours of the harvest-field brought to an end, and the barn-yard filled with the well-built stacks of corn and wheat, than the

farmer is at work with his plough preparing the soil anew for other crops, and diligently restoring to it the needful supplies of manure by which the exhausted chemical ingredients needful for the growth of the plant are restored. This done, the winter wheat is committed to the soil in the last weeks of autumn, so as to pass through the earliest processes of quickening, and shooting up through the soil, before it is hardened into an impenetrable mass, and the whole active vital processes of vegetable life are suspended by the frosts of winter. The process of quickening by which the vital germ of the winter wheat is developed in its first stages, differs in no remarkable degree from that already described among the phenomena of the vegetable kingdom peculiar to spring.

The cereal plants, at every stage of their development, and under every form which they assume by the skill and industrious ingenuity of man, possess a peculiar interest for us. We have already referred to the fact that they are only now known to exist as the fruits of human cultivation, and as such are proved to have been familiar to the earliest historic nations. Wheat has been found wrapped up in the cerements of Egyptian mummies, which was old when our era began, and it is familiar to us in a charred state, among the remains found on Roman sites both in our own and other countries. It is indeed, along with a few other allied plants, among the most essential concomitants of progressive civilization. It is only by the assiduous culture of the cerealia that a country becomes capable of permanently supporting a dense population. The precarious and insufficient substitute afforded by the potato has been abundantly demonstrated by the experience of late years in our own country, and though in some few genial climates, farinaceous food, the pith or roots of certain herbaceous plants, supplied by nature, or procured with little or no culture, furnish the needful supplies for a thinly scattered population, the

human race is invariably found under such circumstances greatly inferior to civilized man. Wheat does not thrive in tropical climates, but its remarkable adaptation to the wants of civilized man is proved by the extensive geographical area over which it is diffused, and the varied range of elevation at which it is successfully cultivated. It grows from latitude twenty-three degrees to latitude sixty-four degrees north, in Europe and Asia. In South America it is successfully cultivated at an elevation of twelve thousand feet; and in the Himalaya mountains it has attained a still higher altitude. It forms an important article of export and import throughout the most populous countries of the old and new world, and is now employed by almost every civilized nation in the manufacture of bread. The substitute for wheat in tropical countries, where that invaluable grain cannot be raised, is rice, which is extensively cultivated in Southern Asia, and is found to grow readily under those circumstances of excessive moisture and warmth which occur in tropical regions, exposed to periodical rains, succeeded by extreme heat. By this means Providence has provided the essential vegetable products for the sustenance of the human race throughout nearly the whole habitable regions of the globe. Rice is found to consist almost entirely of starch, and forms a highly nutritious diet. Owing to peculiar religious opinions, as well as to the habits of a large proportion of the native tribes of Southern Asia, this grain is the chief article of diet, and thus furnishes food for a greater number of human beings than all the cereal plants of temperate latitudes.

Besides wheat, there are several other cereal plants cultivated to a great extent in Europe, and adapted to soils and regions where it will not grow. Rye, which readily grows in dry sandy soils, furnishes bread for a large portion of the population of Northern Germany, France, Denmark, Sweden, and Norway. It is little

cultivated in this country, and English travellers who have visited Norway and Sweden complain of the necessity of eating the native rye-bread as a great hardship; yet such is the force of habit, and the providential adaptation of our tastes and appetites to the circumstance of locality and climate, that we have seen a Norwegian gentleman after a stay of some months in England, receive a portion of dry old rye loaf from the stores of a Baltic trading vessel, as one of the greatest treats that could be offered to him, and as such, a relief from the constant necessity of partaking of wheaten bread. A similar feeling is sometimes expressed by the natives of the north and west of Scotland, where oats are so very generally cultivated and used instead of barley. To them the finest white wheaten bread seems insipid and unsatisfying compared with the coarse oaten cake to which they have been familiar from youth. The oat is one of the most hardy of all the cereal plants, being only equalled in this respect by barley; so extensively employed for conversion into malt, in order to be used by the brewer and distiller. Oats are cultivated over a still wider range than wheat. In India they have been grown in latitude twenty-five degrees, and are successfully cultivated as far north as latitude sixty-five degrees. They afford a wholesome and nutritious food, less palatable, or generally available for culinary purposes than wheat, but in some respects more economic and nourishing as one of the staple articles of food.

The sowing of winter wheat in the last weeks of autumn, is one of the most intelligent applications of reason and experience, by means of which we are enabled to select the seeds best suited to our variable and moist climate, and to treat them in the manner most calculated to overcome its defects, and to render its agricultural capacities fully available. Deposited in the soil before the severity of winter has set in, the first important processes of vegetation are past before the excessive cold has ar-

rested further growth, and the tender shoot is then found perfectly capable of withstanding the ordinary rigour of our winter, so that some of the finest wheat raised in the united kingdom has been produced so far north as Inverness-shire. No sooner is the wheat seed put into the ground, and stimulated by the heat, accompanied with the moisture furnished by the later rains of autumn, so essential to the turnip, carrot, beet-root, and other late crops of the farmer, than the cells of the seed begin to swell out, and the vital powers of the germ are awakened. The juices contained in the cotyledons are set in motion, and communicated to the bud. From the one end of the seed the rootlets begin to make their appearance, and strike downward into the soil. At first they are wrapped in a covering which is speedily burst, and the earliest root descends perpendicularly, while others shoot out in lateral directions searching for the needful nourishment from the soil. Simultaneously with this, the minute *gemmule* or rudiment of leaves appears, and forces its way upwards to the light and air. Under favourable circumstances of heat and moisture the wheat plant will be seen piercing the soil with its sharp green point within seven or eight days after it has been sown. It consists of a small cluster of leaves forming the sheath within which the delicate embryo of the future plant is enclosed, and united together so as to form a wedge admirably adapted for forcing its way with least resistance through the soil. Up to this period, nearly the sole source of growth of the plant has been derived from the seed. It is like an infant which derives its first sustenance from its mother's breast, and such is the earliest process in every case of birth and development from seed in the vegetable kingdom. A curious illustration of this is furnished in the familiar process occasionally resorted to by sailors on a long voyage. Cress-seeds, it is well known, will germinate on a piece of flannel stretched out and kept moist,

and will continue to grow till they assume a development sufficient to render them an acquisition to the seaman's table, in the absence of all other vegetables. They will grow, in fact, until they have exhausted all the nutriment of the cotyledons, and then their growth necessarily ceases, as the roots are deprived of all further source of nutrition, which would in their natural state be drawn directly from the soil.

When the wheat plant has fairly forced itself through the soil, and the lately ploughed field begins to assume a delicate green tint from its late crop, it furnishes an object of interesting study to the botanist and vegetable physiologist. If the plant is now plucked up carefully, the original seed will be found to have entirely disappeared, and nothing remains but the small rooty fibres, and the spike or bundle of green leaves containing the embryo plant. The latter is an interesting subject for minute dissection with the aid of the microscope. When the cluster of outer leaves are unfolded they are found to enclose the minute stem of the future plant, with its knots, from each of which springs a little green leaf. The first of these leaves springing near the root encloses the whole stem, formed apparently of four minute tubes joined together on end. Another leaf rises from the next junction enclosing in like manner all above it, and the same form and arrangement are repeated in the third tube, the leaf of which encloses at the top the embryo ears of grain, already developed. These, when seen through the microscope, are exceedingly beautiful, looking like a cluster of seedling pearls.

The series of enclosing leaves thus provided for the young plant are the swaddling clothes in which it is to lie securely wrapped until the genial influences of spring teach it to shoot forth, and in this state it braves the severities of our northern winter, and remains uninjured throughout all its sudden vicissitudes of frost, snow,

heavy rains, and other extreme alternations of temperature and change: the delicate green leaves retaining their vitality, while the hardy forest trees are spreading their bare leafless branches to the winds. The various leaves which thus enclose and protect the wheat ear, afford an interesting example of the wise provision of means adapted to the minutest vicissitudes and necessities of vegetable life. The outer group of green leaves which form the protecting sheath of the plant throughout its earliest stage, fall down and wither soon after it begins to shoot up in spring, while those springing from the joints of the stem remain, continuing for a time to protect the ear, and afterwards to give strength to the stem. This latter purpose accomplished, they also wither, and towards autumn nothing remains but the slender hollow stalk of straw, surmounted by the ripening ear. This is the autumnal process of the succeeding year. The wheat which has gone on imbibing its constant nourishment from the soil, has at length attained its full size, and waves a luxuriant ocean, ebbing and flowing in delicate green waves under every breeze. The stem is constructed so as to combine the utmost strength with its light and slender form, and rarely gives way under the influence of the most violent winds, unless when sudden, heavy, and long continued rains lay it prostrate, and continue to beat on it until its elasticity is destroyed. The healthful plant having at length reached the maturity of its growth, the flow of sap begins to decrease, the delicately formed ducts by means of which the juices have circulated through the stalk, grow hard and cease to perform their office; the leaves of the stem wither and shrivel up, and the hardening stem and ear begin to assume the golden hue of the ripening grain.

In considering this interesting illustration of vegetable development under the peculiar changes of our climate, we are naturally led to consider the singular phenomena which disclose to us the evidences of a wise and provi-

dential adaptation of vegetable life to the length of the year, and the periodicity of the seasons. Whewell remarks on the recurrence of the successive stages in the development of plants at intervals corresponding to the various sub-divisions of our solar year: "Undoubtedly this result is in part occasioned by the action of external stimulants upon the plant, especially heat, and by the recurrence of the intensity of such agents. Accordingly, there are slight differences in the times of such occurrences, according to the backwardness or forwardness of the season, and according as the climate is genial or otherwise. Gardeners use artifices which will, to a certain extent, accelerate or retard the time of development of a plant. But there are various circumstances which show that this recurrence of the same events, and at equal intervals, is not entirely owing to external causes, and that it depends also upon something in the internal structure of vegetables. Alpine plants do not wait for the stimulus of the sun's heat, but exert such a struggle to blossom, that their flowers are seen among the yet unmelted snow. And this is still more remarkable in the naturalization of plants from one hemisphere to the other. When we transplant our fruit-trees to the temperate regions south of the equator, they continue for some years to flourish at the period which corresponds to our spring. The reverse of this obtains, with certain trees of the southern hemisphere. Plants from the Cape of Good Hope, and from Australia, countries whose summer is simultaneous with our winter, exhibit their flowers in the coldest part of the year.

"This view of the subject agrees with that maintained by the best botanical writers. Thus De Candolle observes that after making allowance for all meteorological causes, which determine the epoch of flowering, we must reckon as another cause the peculiar nature of each species. The

flowering once determined, appears to be subject to a law of *periodicity* and habit.

"It appears then that the functions of plants have by their nature a periodical character; and the length of the period thus belonging to vegetables is a result of their organization. Warmth and light, soil and moisture, may in some degree modify, and hasten or retard the stages of this period; but when the constraint is removed the natural period is again resumed. Such stimulants as we have mentioned are not the *causes* of this periodicity. They do not produce the varied functions of the plant, and could not occasion their performance at regular intervals, except the plant possessed a suitable construction. They could not alter the length of the cycle of vegetable functions, except within certain very narrow limits. The processes of the rising of the sap, of the formation of proper juices, of the unfolding of leaves, the opening of flowers, the fecundation of the fruit, the ripening of the seed, its proper deposition in order for the reproduction of a new plant:—all these operations require a certain portion of time, and could not be compressed into a space less than a year, or at least could not be abbreviated in any very great degree. And on the other hand, if the winter were greatly longer than it now is, many seeds would not germinate at the return of spring. Seeds which have been kept too long require stimulants to make them fertile.

"If therefore the duration of the seasons were much to change, the processes of vegetable life would be interrupted, deranged, distempered. What, for instance, would become of our calendar of Flora, if the year were lengthened or shortened by six months? Some of the dates would never arrive in the one case, and the vegetable processes which mark them would be superseded; some seasons would be without dates in the other case, and these periods would be employed in a way hurtful to the plants, and no doubt speedily destructive. We should

have not only *a year of confusion*, but, if it were repeated and continued, a year of death."*

In this, as in so many other arguments of natural theology, the inquiring mind is undoubtedly tempted to look upon the facts which form the basis of such reasoning, as possibly only the surviving residuum of an existence, formerly greatly varied. The geological evidence of vegetable life, as it existed at periods long prior to the historic era in temperate climates, leaves no room to doubt, that tropical plants once flourished within the temperate zone. We lack, however, all evidence of the nature of those physical changes which have affected our globe, during the vast periods in which continents have been upheaved and submerged, estuaries filled up and again buried at vast depths beneath superimposed strata, and the entire surface of the planet completely changed. Such arguments may indeed throw difficulties in the way of establishing a complete system of theology, based only on the study of nature, but such an aim we have already very distinctly disclaimed, considering it totally unattainable, and regarding natural theology as only valuable when employed as an auxiliary to revealed truth. Whewell has justly remarked in reference to the view of the argument above suggested: "It cannot be accepted as an explanation of this fact in the economy of plants, that it is necessary to their existence; that no plants could possibly have subsisted, and come down to us, except those which were thus suited to their place on the earth. This is true; but this does not at all remove the necessity of recurring to design as the origin of the construction by which the existence and continuance of plants are made possible. A watch could not go, except there were the most exact adjustment in the forms and positions of its wheels; yet no one would accept it as an explanation of the origin of such forms and positions, that

* Whewell's Bridgewater Treatise, p. 25.

the watch would not go if these were other than they are. If the objector were to suppose that plants were originally fitted to years of various lengths, and that such only have survived to the present time, as had a cycle of a length equal to our present year, or one which could be accommodated to it; we should reply, that the assumption is too gratuitous and extravagant to require much consideration; but that, moreover, it does not remove the difficulty. How came the functions of plants to be *periodical* at all? Here is, in the first instance, an agreement in the form of the laws that prevail in the organic and in the inorganic world, which appears to us a clear evidence of design in their Author. And the same kind of reply might be made to any similar objection to our argument. Any supposition that the universe has gradually approximated to that state of harmony among the operations of its different parts, of which we have one instance in the coincidence now under consideration, would make it necessary for the objector to assume a previous state of things preparatory to this perfect correspondence. And in this preparatory condition we should still be able to trace the rudiments of that harmony, for which it was proposed to account: so that even the most unbounded license of hypothesis would not enable the opponent to obliterate the traces of an intentional adaptation of one part of nature to another.

"Nor would it at all affect the argument, if these periodical occurrences could be traced to some proximate cause: if for instance it could be shown, that the budding or flowering of plants is brought about at particular intervals, by the nutriment accumulated in their vessels during the preceding months. For the question would still remain, how their functions were so adjusted, that the accumulation of the nutriment necessary for budding and flowering, together with the operation itself, comes to occupy exactly a year, instead of a month only, or ten years.

There must be in their structure some reference to time: how did such a reference occur? how was it determined to the particular time of the earth's revolution round the sun? This could be no otherwise, as we conceive, than by design and appointment."*

Here, then, we find a remarkable adjustment between two things differing widely in their relations to each other. The dimensions of the solar system, and the relations of its various parts, are seen to be so harmoniously adjusted, as not only to mutually balance each other, but to regulate such minute occurrences as the periodical development of vegetable life on our planet. Doubtless the same relations of the whole system to its several parts contribute, in like manner, to the functions of life or the processes of development, and the wise designs of creative intelligence throughout the whole planetary system, binding all together by mysterious links of affinity and mutual relationship, like the members of one family, co-operating, and interchanging affections and duties, under the eye of the great Father of the universe.

CHAPTER V.

THE HARVEST COVENANT

It may seem scarcely needful, amid the varied evidences of the workings of Providence for the supply of every want and necessity of man, to refer more pointedly than we have already done, to the value of that gracious promise which secures to us the continuance of fertile harvest fields while the earth shall remain. The recent experience, however, we have had in the British Islands, of the terrible and lasting effects which may flow from even the partial failure of one of the secondary products of our

* Whewell's Bridgewater Treatise, p. 29.

annual harvest, has taught us how vast are the consequences involved in the integrity of that Divine covenant. The world had gone on throughout the long period from Adam to Noah, with the annual round of the seasons, the daily rising and setting sun, the alternations of rain and sunshine, of heat and cold. Nature had remained unchanged since the ground was cursed for man's sake, and demanded the labours of the husbandman to substitute for its waste thorns and thistles the rich harvests of grain. Year by year throughout the prolonged existence of the antediluvian patriarchs, had men seen the seasons pass through their appointed course, until they had persuaded themselves that what they saw was the eternal order of things, and in the spirit of others who succeeded to their inheritance, they exclaimed,—" Where is the promise of his coming? for since the fathers fell asleep all things remain as they now are!" In one repect, however, all things had not remained unchanged. Man, who had fallen away from the state of purity and innocence in which he was created, had gone on in a course ever leading him further away from God. Men began to multiply on the earth, and passion, vice, and crime had terribly increased. The protracted years of man during the first ages of the world doubtless added an additional influence. The hoary sinner went on ever plunging deeper in his downward course, and contaminating the new generations that rose up around him, until they became abandoned to every lust and crime, and intolerable in the sight of heaven. And God saw that the wickedness of man was great in the earth, and that every imagination of the thoughts of his heart was only evil continually; and it repented him that he had made man on the earth. And the Lord said, I will destroy man, whom I have created, from the face of the earth; both man and beast, and the creeping thing, and the fowls of the air; for it repenteth me that I have made them.

Little heeded the generations of the antediluvian patriarchs the accusing conscience within them, all seared as it was, when it still muttered forth its warnings. Noah found grace in the eyes of the Lord; all else abandoned themselves to the lusts and pleasures of their own evil hearts. In the days that were before the flood, they were eating and drinking, marrying and giving in marriage, until the day that Noah entered into the ark; and knew not, until the flood came and took them all away. A fearful state of things must have existed among the men of that age, as among the citizens of the plain over which the bitter waters of the Dead Sea now sweep. The forbidden fruit of the knowledge of good and evil had yielded to them only the knowledge of evil. They had eat of the accursed fruit; had sown the wind and reaped the whirlwind; until at length the whole earth, with its innocent and its guilty living creatures, became intolerable in the sight of heaven because of them, and God swept the whole away with a flood of destruction. The first thing which the rescued patriarch did, when the flood had subsided, was to build an altar to the Lord; but, for all that, man was what he had ever been since the day that Eve rejoiced at the birth of Cain, and said: "I have gotten a man from the Lord!" And when the savour of that first sacrifice of the new generations rose up to heaven, God said in his heart, "I will not again curse the ground any more for man's sake; for the imagination of man's heart is evil from his youth." To man, however, this flood was a fearful evidence of the instability of earthly things. The windows of heaven had been opened; the fountains of the great deep had been broken up, and how knew he how soon this might recur again, since the imaginations of man's heart remained evil as before? In such a state of mind it might well have seemed vain and useless to till and reap, to gather into store-houses, or provide for anything beyond the passing moment. But

God mercifully sympathized with his creatures, even because of the very hopelessness of their state, and the evil imaginings of their hearts, and said: "I will not again smite any more everything living as I have done. While the earth remaineth, seed-time and harvest shall not cease." They were to put in their ploughshare above the grave of the old world, to cast in their seed, and to reap their harvests from the alluvium of the very flood which had swept every living being but themselves to destruction. How needful, therefore, was it for that solitary family, in its terrible loneliness amid the wreck and desolation of the world, to be assured of the stability and order and permanence of creation, and of the gracious and merciful designs of Providence towards man.

No less valuable to us is the assurance of the stability of nature and the security of annual harvests. In our own day, war has swept across the continent of Europe, desolating countries, sacking and firing cities, and sweeping millions to sudden destruction, or by slow and wasting famine to equally certain death; yet we have recently seen how awfully surpassing even the terrors of war may be the blight on the fruits of the field, and the seed-time without the harvest. The king of Israel was once placed in the terrible dilemma of choosing between scourges such as these. For when David was up in the morning, the word of the Lord came to the prophet Gad, David's seer, saying: Go and say unto David, "thus saith the Lord, I offer thee three things; choose one of them, that I may do it unto thee. So Gad came to David, and told him, and said unto him, shall seven years of famine come unto thee in thy land? or wilt thou flee three months before thine enemies, while they pursue thee? or that there be three days' pestilence in thy land? now advise and see what answer I shall return to him that sent me? And David said unto Gad, I am in a great strait: let us fall now into the hand of the Lord, for his mercies

are great, and let me not fall into the hand of man." So the Lord sent a pestilence upon Israel, from the morning even to the time appointed, and there died of the people seventy thousand men. Such a choice was indeed terrible to have to make, yet we have seen what the year of famine must produce, when by the partial failure of our potato crop, there died in Ireland in one year, notwithstanding the expenditure by public and private means, of enormous sums of money, upwards of fifty thousand men, women, and children, in the work-houses alone; while a far larger number were perishing beyond their miserable pale, or seeking to escape from the scene of misery and death, by emigration to other lands, regardless of wife or children, or of any patriotic tie, or claim of duty or affection. A strange state of things had been brought about in Ireland by the substitution of the potato for the older cereal harvests, as the staple food of the people. Producing as it did a large quantity of food, such as it was, without great necessity of labour or exertion of any kind, the people seemed to sink under its influence into the state of savages who depend on the chance products of the soil and the chase, and know no law of prudence, self-denial, or restraint of any kind, except that of sheer necessity, such as controls the unreasoning brute. Previous to the terrible famine of 1847, the agricultural labourers of Ireland stood to those of England in the proportion of five to two, when compared with reference to the extent of land in cultivation: while, so far from this being accounted for by a corresponding surplus of produce in Ireland, the Irish labourers stood to the English in the ratio of even four to one, when compared with reference to the produce raised.

The physical condition of the poor Irish labourer was already miserable indeed: he had grown reckless, moreover, and so regardless alike of every economic and moral restraint, that the population went on increasing, while the

means of its subsistence appeared already reduced to the minimum of possible sustenance of life. In such a state of things, it was obvious that the first great failure of produce, if continued for any considerable time, must break up both the social and the agricultural system of Ireland; and must do so, not by degrees, but accompanied by the calamities which attend convulsive changes. The great evil of an agriculture based on the potato was, that partly from its extraordinary productiveness, partly from the social relations produced by such a system, it superseded, to a large extent, the primal law of labour,—as the cultivation of the bread-fruit tree, on a large scale, would yet more fatally do,—and established no proportion between numbers and employment. It is computed that there were two millions of acres under the potato culture; and on the ordinary calculation that it requires three acres even of oats to produce as much human food as one acre of potatoes, a new creation of land to the amount of four millions of acres, would have been necessary, in order to support on cereal food the population previously maintained on potatoes. But such a creation being impossible, there remains only one alternative,—either the removal of the unemployed population to regions in which food is abundant and a large demand for labour exists, or else the introduction of a greatly improved system of agriculture. The latter is the course which we should prefer, if, as has been too often assumed, with a calamitous rashness, the two were really separate and independent courses: but it seems impossible, on mature reflection, to deny, that for a sound system of agriculture, the very first requisite must be the withdrawal from the country of those who cannot find employment there, and who hang like a dead weight on the industry of others.

In such a strangely confused and discordant state of things, the failure of the potato harvest came like one of those fearful hurricanes which sweep through tropical

regions, carrying destruction and death in their train, yet also sweeping away the noxious sources of pestilence, and proving in the end a blessing instead of a curse. Seeing, however, what were the consequences in Ireland, and the whole kingdom, of the failure of the potato crop, we may the more readily conceive the consequences that would flow from the general cessation of the harvest for a single year. Not all the vast wealth of England would avail to stay the terrible consequences. The blight, such as some insignificant fly or caterpillar might produce on the cereal crops of a single season, would prove more terrible in its consequences than all the most frightful devastations of war. It is not therefore without reason that we refer to the uniform stability of nature, as one of the most remarkable evidences of the overruling providence of God.

CHAPTER VI.

MIGRATION OF BIRDS.

As we advance in the consideration of our subject, its most salient points narrow around us, though there is still abundant subject for our consideration, serving to illustrate the same course of argument which has been pursued through the earlier chapters of this volume. The functions of insects may be said to be nearly all completed, and their duties fulfilled, before autumn has set in. In the warm harvest weather of the early part of autumn, the bees are still busy with their industrious toil; and the various butterflies, as well as innumerable smaller and less showy insects, are still flitting about from flower to flower. As the season advances, however, these rapidly diminish, and by the middle of September, even when the weather remains mild and genial, very few are

to be seen. With the feathered tribes it is altogether different, and we are now to consider a peculiar class of habits and instincts pertaining exclusively to this season of the year.

The young broods reared in the past season are now all on the wing, and for the most part independent of parental care. The music of the grove has now also almost entirely ceased, and a large portion of the feathered tribes that made our woods vocal in the spring, or enlivened the scene with their parental labours and graceful movements, are now preparing to wing their way in search of a warmer climate wherein to pass the winter. Among the migratory birds, there is reason to believe that the parental duties do not altogether cease until the young brood have been safely conducted to the remote scene of their winter sojourn. As the autumn sets in, they may be seen flying about, sometimes in flocks, and in other cases apparently in family groups, the parent birds being engaged, to all appearance, in preparing their inexperienced brood for the long and perilous journey which is before them. Few incidents connected with the instincts of the lower animals more remarkably indicate the wise and providential oversight of the Creator over his works, than the annual migrations of birds, and none can be selected so peculiarly characteristic of any of the seasons as they are of the autumn. The migration of birds is obviously designed in order that they may escape the privations consequent on the diminution of their natural food, and the fall of the atmospheric temperature below what they are able to bear. The former, however, is the chief reason, especially with the purely insectivorous birds, which must necessarily be deprived of all food during most winters in our climate. Yet it is specially worthy of our notice that birds are not impelled to forsake our climate for warm regions, by the failure of their proper nourishment; for by far the greater number disappear in the early part of

autumn, before any perceptible failure can have taken place in the supplies of their food, and while the weather is yet fine, and the changes effected by autumn on the aspect of nature are much too slight to give any direct premonition of the coming winter.

Various attempts have been made by scientific naturalists to account for the remarkable regularity of the annual departure and return of different species of birds; but as yet it remains as mysterious and inexplicable as any of the other remarkable manifestations of instinct which have been previously considered. These birds are created with appetites for a species of food which cannot be obtained under our wintry skies, and require, moreover, a milder climate than the chill breath of the closing season of our year. Such requirements have, accordingly, been provided for by a secret but unerring impulse, which teaches them at the appointed season to wing their way across oceans and continents, and to fix their habitations under more genial skies, until the season again returns in which they resume their airy journey, and come back to gladden our mild summers with their presence. In this way a large proportion of the feathered tribes spend a considerable portion of every year in travelling from northern to southern climes, and returning again when the season of cold or heat is past. Towards the close of autumn, our country is deserted by a large proportion of the whole feathered tribes which have given life and animation to wood, and park, and common, throughout the spring and summer, and have built their nests, and reared their young as natives of the soil; but in lieu of these, another class of sojourners succeed to them, who have spent their breeding season in the far north, and return to enjoy our milder winters, along with their young broods, when the iron chains of winter have once more bound in their dreary silence and desolation the regions within the arctic circle. Birds appear for the most part to travel during

the night, ascending to a great height beyond the reach of all ordinary obstructions to their flight, and stopping only during the day at places where their food is most easily procurable without danger. The immense powers of flight, however, which nearly all migratory birds possess, expose them to little risk of danger from the few pauses for food or rest which they require to make during their longest journeys. Repeated experiments with carrier pigeons leave no room to doubt that they are capable of maintaining a continuous flight at the rate of seventy, eighty, and even ninety miles an hour, so that the speed of our swiftest express railway trains is far outstripped by those tiny winged messengers.

It is impossible to overlook the various evidences of providential care and design manifested in the operations of this singular instinct among the numerous families of the feathered tribe. By its means, the desolate, frozen regions of the remote north are animated and instinct with life during the brief arctic summer. The dreary and silent coasts become vocal with the songs and animating cries of numerous flocks of birds cheerfully engaged in the parental duties of rearing and hatching their brood. These are trained to join the parent birds in their adventurous flight to the southward, guided by their unerring instincts over land and ocean, for many hundred miles, more safely without beacon or compass, or knowledge of the starry guides of the seaman, than the boldest and most experienced pilot, housed in the well appointed whaler, with all the appliances that science can suggest for the arctic voyage.

The migration of birds continues in Britain throughout the whole autumn and winter: the three former months being occupied with the departure to the south of those which have reared their broods under our mild spring and summer skies, while the months of winter are cheered by the arrival of others from the north, bringing with them

their full fledged broods to enjoy the transition from the brief arctic summer to our milder winter. Thirteen different species of our British birds take their flight to the southward in the month of August, while the warmth of summer has scarcely perceptibly diminished, and the rich foliage of trees, and the bloom of flowers, give little indication of the coming change. These are followed in September by twenty-nine other species; and nine more linger with us almost till the close of October. The arrivals are in like manner distributed over the three winter months, and thus the busy round of the seasons is maintained with an endless variety of life, industry, and full enjoyment.

Among the first of the feathered tribe to forsake our shores, is the swift or martlet. In the first weeks of August, they may be seen darting about through the air, on their untiring wings. The young ones are now full grown, and the abundance of insects, as well as the mildness of the early weeks of harvest, with the clear skies and warm air, seem all to offer every inducement to their stay. Yet, guided by unerring instinct, they disappear, winging their way to the south, and give us one of the earliest warnings that the winter is at hand. The house swallow, another of the same familiar and interesting tribe of birds, lingers with us till a later period. Towards the middle of September, when the nights are visibly lengthening and growing proportionably chill, the swallows may be observed gathering in considerable numbers on the ridge of the church, or on the roof of some large barn or out-house, from whence they rise together and fly about, going through many singular aerial evolutions, and seemingly sporting together in the air. This is repeated from day to day, as if to practise and strengthen their pinions, and prepare the birds of the first year for their long southern flight. At length the time for their departure arrives. Their numbers have been continually

augmenting, and by some singular means they seem to communicate with each other, so as to effect all their movements in concert. When at last they take their departure, they rise altogether in one dense column, and, without any of their former gambols or evolutions, fly off in a direct course towards the south. After this it is rare indeed to see a swallow until the succeeding spring. Mr. Jesse remarks: "I am indebted to the kindness of an intelligent and observant correspondent, in Lancashire, for the following remarks on the migration and re-appearance of the swallow in the year 1832. He informed me that the middle and end of the month of September, in that year, were remarkable for the mildness of the weather, for bright sunshine, and abundance of the insect tribe. On the twenty-fifth of that month, which was a warm and fine day, the common swallow (hirundo rustica) was skimming about as alertly as in the middle of summer, but on the twenty-sixth it was no longer to be seen. They appeared at once to have taken their departure. The martin (hirundo urbica) still remained in considerable numbers; and on the fourth of October many of them were seen, but only one solitary chimney swallow.

On the 7th of October the rapid fall of the barometer announced either the approach of a storm, or of some great change in the weather; although throughout the day it continued mild and placid. In the afternoon, great numbers of the common swallow were skimming and flying about, apparently in full vigour, both of health and plumage. They appeared, to use a nautical phrase, to have 'put back,' for on the next day the mercury dropped rapidly more and more. In the course of the morning a most fearful and violent tempest of wind and rain arose from the west and south-west, causing dreadful disasters on the coast, attended with considerable loss of life.

After this statement, the question may very naturally

be asked, whether or not these poor birds, perceiving indications of the coming storm, when over the surface of the ocean, had returned to the coast of Lancashire in order to avoid it? This was most probably the case; and if so, it shows wonderful foresight, and instinctive knowledge of the danger they would encounter in continuing their course to distant regions. It would also be an interesting thing to ascertain, whether they were emigrants from the north of England, from Scotland, or from Ireland. If from the south of England, they might have been expected to have landed in the south rather than in Lancashire.

Not a single martin was visible amongst these swallows, nor was one seen in the neighbourhood after the fourth of October.

If the swallows returned to avoid the coming tempest, they seemed reluctant to resume their migration, as on the fifteenth of October several of them were seen, and on the twentieth of that month a pair of them were observed about a mile from Liverpool, occasionally flying about, and sometimes perched on the cornice of a house, enjoying the sunshine, apparently healthy and alert.

Another instance of the re-appearance of swallows after their migration, was also observed at Liverpool, a few years previous to the example already recorded. In that case their re-appearance was attended with violent gales of wind, which caused many vessels to put back into port.

It may be mentioned that the retired master of a vessel, who for many years commanded a ship trading between Liverpool and the West Indies, assured my correspondent, that when he was in the Atlantic, it has occasionally happened, particularly after strong breezes from the eastward, that considerable numbers, both of swallows and martins, had alighted on the rigging and other parts of the ship. In general they soon died, and, as was

conjectured, for want of food. The vessel at the time was hundreds of miles from the continent of Africa, to which country these indefatigable emigrants were probably resorting."

The same interesting writer remarks of the swallow's departure from our country in the autumn:—"Although I have only on one occasion seen the arrival of my favourite birds, I have on several occasions witnessed their departure. The large old buildings which are found in the neighbourhood of the river Thames, are much frequented by swallows and martins in the autumn. Here they congregate in immense numbers, and also on the tops of the surrounding high trees, sometimes taking a flight as if by one consent, and then returning to the same spots again. At night they roost in countless numbers on the willows growing on the different aits or small islets on the river. Their final departure seems to depend on the state of the weather, but generally takes place towards the evening. They ascend to a considerable height, and soon afterwards not one is to be seen. That migratory birds are enabled to take their unerring flight during the night cannot be doubted. They neither require a star to guide nor a moon to light them, and yet they are enabled to traverse the trackless ocean to far distant countries, till they return to enliven us again with their presence."

Many other curious and equally remarkable evidences of the singular display of instinct in the feathered tribes, guiding them in their annual migrations, might be referred to, but these are sufficient to illustrate the nature of this wonderful impulse by which they are guided to their summer and winter retreats, and are safely led to regions thousands of miles apart to propagate and rear their species, and find for them fitting and abundant supplies of food, and a climate best adapted to their peculiar habits. The migration of fishes, also, to some extent, corresponds with that of birds, and controls the movements of those

who seek within the arctic circle the safest summer haunts for bringing forth and rearing their young.

CHAPTER VII.

THE CLOSE OF AUTUMN.

THE autumnal season is the busiest of all the year—its work comes on the farmer whether he will or no, and must be attended to, if he would not lose the reward of all his previous labours. It is a season of earnest expectation, and of hope and desire mingled with many anxieties. The change from the waving fields of the green summer crops to the autumnal gold is sudden and abrupt. The fields seem almost to ripen before our eyes, and then is the period of keenest anxiety to the husbandman, when the cup seems just proffered to his lip, and yet he knows by experience to dread the thousand slips which may come to dash it away, and cheat him of the draught for which he thirsts. Sometimes the grain has ripened, and shearers cannot be found, and occasionally when all is ready, and the overseer only waits a suitable morning to begin the reapers' work, one of these sudden gales which occasionally occur in autumn will come, and in a single night strew the ground with the best of the grain. Incalculable damage is frequently done by this means, and the farmer has the misery of looking on, conscious that it is utterly beyond his power to arrest it. The grain being then fully ripe in the ear, the largest and finest grains are invariably at the lower part: the ears of corn or wheat ripening upward precisely as we may observe the monk's-hood or common fox-glove do. When, therefore, the ripened grain is violently shaken by a sudden gale, the whole of these finest grains are shaken out and irretriev-

ably lost. To employ the beautiful simile of Scripture, which, though spoken in reference to a far more solemn occasion, is singularly appropriate here: They are as water spilt upon the ground, which cannot be gathered up again. By such autumn gales, we have known of the loss of hundreds of pounds' worth in a single night, the whole grain of a district being by this means deteriorated in quality, and thus greatly lessened in value, in addition to the positive diminution of its bulk. It is with just and striking force, therefore, that the anxieties of the husbandman are so frequently referred to by the inspired writers, to express the nature of our longings and anticipations of the fulfilment of the heavenly promises. He sows in hope, and having committed his seed to the well-prepared soil, he watches and waits for the sunshine and the rain, and the dews of heaven, to bring him in the desired reward. "Behold, the husbandman waiteth for the precious fruit of the earth, and hath long patience for it, until he receive the early and latter rain."

The labour of harvest being over, however, a striking change succeeds. Where the waving fields of corn were so lately seen, or the busy reapers and the laden wains, now only appear rough stubble-fields, save where the plough has been anew at work, turning up the fresh soil for the autumnal sowing of the winter wheat. The sere leaves are falling thick around us. The bare hedge-rows disclose the birds' nests which the eager school-boy had looked in vain for during the summer. The plantations and park clumps which shut in the fields, and clothed the glens with a verdant curtain, within which were heard the sweet murmurs of the hidden rivulet, are now a naked piece of net-work, disclosing all within and beyond, save where here and there the tardy foliage of the oak still clings sturdily to the boughs, and the beech retains its deeply embrowned leaves in expectation of the bursting of new buds in spring. The transition, however, is a

very gradual one. Leaf after leaf drops, tint after tint creeps over the forest, and the year slowly and gracefully wanes from autumn to winter, not without many a pleasing and beautiful change, peculiarly characteristic of the "season of the slowly fading year." Sir Walter Scott has thus beautifully depicted the character of this season, as its most striking features appear to the eye of the poet when drawing near its close :—

"Autumn departs—but still his mantle's fold
Rests on the groves of noble Somerville,
Beneath a shroud of russet dropped with gold
Tweed and his tributaries mingle still;
Hoarser the wind, and deeper sounds the rill,
Yet lingering notes of sylvan music swell,
The deep-toned cushat, and the red-breast shrill;
And yet some tints of summer splendour tell
When the broad sun sinks down on Ettrick's western fell.

"Autumn departs—from Gala's fields no more
Come rural sounds our kindred banks to cheer;
Blent with the stream, and gale that wafts it o'er,
No more the distant reaper's mirth we hear.
The last blithe shout hath died upon our ear,
And harvest-home hath hushed the clanging wain,
On the waste hill no forms of life appear,
Save where, sad laggard of the autumnal train,
Some age-struck wanderer gleans few ears of scattered grain.

"Deem'st thou these saddened scenes have pleasure still,
Lov'st thou through Autumn's fading realms to stray,
To see the heath-flower withered on the hill,
To listen to the wood's expiring lay,
To note the red leaf shivering on the spray,
To mark the last bright tints the mountain stain,
On the waste fields to trace the gleaner's way,
And moralize on mortal joy and pain?
O! if such scenes thou lov'st, scorn not the minstrel strain.

"No! do not scorn although its hoarser note
Scarce with the cushat's homely song can vie,
Though faint its beauties as the tints remote
That gleam through mist on Autumn's evening sky,
And few as leaves that tremble, sear and dry,
When wild November hath his bugle wound;
Nor mock my toil—a lonely gleaner I,
Through fields time-wasted, on sad inquest bound,
Where happier bards of yore have richer harvest found."

CHAPTER VIII.

CHARACTERISTICS OF THE SEASON.

It would be easy to lengthen out the dissertation on the peculiar characteristics of Autumn, by the description of many illustrations and details connected with the subjects already referred to, as well as by the addition of other chapters devoted to the elucidation of phenomena more especially pertaining to the season of harvest. By treating our theme in this manner, the autumnal phenomena might be made to include the radiation of heat from the earth; the formation and deposition of dew; the rain-cloud and the thunder-storm; with all the wonderful phenomena of electricity, and the practical application of the magnetic needle, not only to navigation, but in its more recent form, as the indicator of the electric telegraph. These, and many other subjects, might fairly enough be included in a work devoted to the elucidation of the evidences of Divine wisdom and design, as displayed in the course of the seasons. But by such a mode of treatment the subject would become nearly inexhaustible, and would demand the space of an encyclopædia, rather than of a volume, for the materials which it must embrace.

Mr. Thomas Griffiths remarks, in his "Chemistry of the Four Seasons"—a work in which he aims at the illustration of the whole range of natural phenomena embraced within the limits of that comprehensive science:—"Changes, miraculous and perpetual, pervade throughout the creation, and yield an inexhaustible store of materials, which are continually presented, withdrawn, and again renewed for mental reflection and experimental investigation.

"The vital force displayed by vegetation, from the

hour of its germination, and throughout all its successive periods of growth towards maturity, in obedience to the immutable laws of its Creator, is a subject well calculated to draw attention from the servant and interpreter of nature.

"In spring, when a seed is buried in the earth, this medium, on account of the hardness and solidity of its constituent atoms, might be reasonably imagined capable of exerting such rude pressure upon the first germs of vegetable life, as to crush it almost in the very moment of its nascence, but experience teaches us that no such injury is sustained.

"When the entire organic structure is once endowed with vitality, its powers become superior to those of inorganic matter; for example, the 'radicle' sends forth soft and tender filaments, yet having sufficient strength during their search for liquid nutriment, to penetrate between hard solid stones, and these filaments, in obedience to gravitation, descend beneath the earth to form a firm and steady root.

"The 'plumula' simultaneously sends forth delicate and fragile folds, having a nearly equal, though contrary strength, during their search of other nutriment from the air, to part asunder, and lift before them, the incumbent atoms of their terrestrial prison, and thus to emerge amidst the ethereal treasures of light and heat, under whose combined attraction the folds burst into full leaves, a perfect plant soon flourishes, and it is destined in due season to 'yield seed after its kind,' which in its turn will then present the same miraculous circle of changes.

"When natural or artificial obstacles of great size, solidity, or weight, are opposed to the comparatively small, slender, and light structure of plants, attraction of gravitation and attraction of cohesion both combine to render the former of superior power to the latter; but, in such cases, although the organic forces cannot directly pene-

trate or lift these obstacles, they preserve as closely as possible the direction that they would have pursued, if not opposed, and will recover it at the earliest opportunity.

"The endeavour of plants to remove obstacles opposed to the ordinary direction of their growth, and failing of it, then gracefully yielding obedience to them, seems to have been first remarked in the case of a basket covered with a flat, square stone, which was accidentally placed in the centre of a growing 'acanthus,' the leaves of which being diverted from their original position, assumed a bending beauty of form, and from this it is said originated the elegant Corinthian capital.

"In pure Corinthian architecture, the acanthus entirely surrounds with its aspiring leaves the basket or vase of the capital, as if attempting to raise the flat stone or abacus that covers the whole, they then turn down and form themselves in graceful volutes.

"It is occasionally observed, that when plants cannot remove solid obstacles, they will actually enclose them within their own structures; thus, nails and stones have been found imbedded in the trunks of trees, and some Indian nations take advantage of this fact for the construction of their hammers; they split open the supple stem of a creeping plant, then place an oblong piece of heavy stone in the aperture, and bind it fast with the shoot of another plant of the same kind which is in a growing state; by the end of twelve months the stone is firmly interlaced, the stem which bears it is cut away, and thus a rude hammer is obtained."

The same author has devoted the autumnal section of his volume to an interesting series of illustrations of heat, mist, rain, dew, the decomposition of animal and vegetable matter, and many other kindred themes, naturally suggested by some familiar change, or common occupation of the season. From this we will extract a pleas-

ing scientific elucidation of one of the natural phenomena of the season, thus happily illustrated among the characteristics of autumn:—"The night has been serene, the moon and stars have shed their brilliant light, no clouds have obscured the heavens, no rain has fallen, and yet when we step forth at daybreak, we find the grass and the flowers of the field loaded with myriads of drops of water, sparkling like gems in the golden rays of the rising sun.

We recognise this beautiful phenomenon as dew;—but from whence has it silently journeyed and arrived during the hours of night?—can the chemist reply?

He can; and the reply will furnish another example of the power and goodness of God, for 'His favour is as dew upon the grass;' another proof of the ever-watchful care of Him with whom 'the darkness and the light are both alike,' whose hand is equally extended for the protection of the animated creation during its noontide activity and its midnight repose.

Throughout the fervent glow of a summer or autumnal day, the solid opaque earth absorbs heat; this abides upon its mere surface, and is not conducted beneath; but at sunset, if the sky be cloudless and calm, the earth immediately radiates part of the heat upward, and soon becomes many degrees colder than the air directly incumbent upon its surface; accordingly the watery vapour that is present in the yet warm air, is chilled or condensed into drops of water, and these 'distil as the dew' upon the earth, for the refreshment of its productions.

This phenomenon cannot fail of appearing remarkable, even to the most careless observer, and it becomes yet more so, when accurately investigated by the chemist. Examine a garden immediately after sunrise at this season; probably the grass-plant is saturated with dew, the gravel walk is nearly dry; the leaves of the hollyhock are dripping with water; the leaves of the laurel are free

from moisture; but all these objects were similarly exposed to the night air, and if dew were a fine rain, as some persons imagine it to be, all should be equally covered with its drops; why is this difference observed?

Because the surfaces of the various objects differ in their radiating power; the grass-plant and the leaves of the hollyhock are excellent radiators; they throw off heat with great energy, and so becoming cold, they induce a more copious deposition of water from the air than the gravel-walk and the laurel leaves, which, being bad radiators, retain heat, and remain so warm that the watery vapour in the air wafts over their surfaces without being chilled or condensed, and therefore they are free from dew.

Rough or woolly leaves, like the painted or sanded surface of a tin-plate, radiate heat most rapidly, whilst smooth or varnished leaves, like the polished, or bright surface of the tin-plate, do not radiate with such energy, and as a consequence of this, the former leaves ensure a more plentiful deposition of dew than the latter.

From the limits of the garden, let us carry forth these observations and facts into the boundless fields of nature, and discover the miraculous workings of Providence.

Barren rocks and soils, by reason of their peculiar hard and compact structure, have neither the power of absorbing nor of radiating heat with great energy, they do not speedily acquire a low temperature during the clear nights of summer and autumn, and as a consequence, dew is scarcely, certainly not abundantly, deposited upon them; it is not required for their support, and they have no vegetable life, or but little of the lowest grade to maintain.

Like every treasure from the bountiful hand of God, the precious 'dew of heaven' is not lavished and scattered upon objects that are unfitted for its reception, and therefore can derive no benefit from its genial influence,

but only abundantly upon such as are properly prepared, and accordingly these obtain wholesome nurture, and bring forth good fruit, whilst the former remain as barren stones.

Naturally fertile soils, and such as are artificially rendered productive, are generally of a loose porous structure; this physical peculiarity enables them to absorb heat abundantly during the day, and to radiate it so powerfully at night, or, in other words, to become so many degrees colder than the ambient air, that its watery vapour condenses upon them and their productions as dew in abundance.

It is indeed a subject well calculated to arrest our attention, and excite our admiration and gratitude, when we thus find every soil, plant, shrub, and tree, has, by its own physical peculiarity of structure, induced the deposition of dew in proportion to its wants; and when we reflect that not a single dewdrop is created in vain, but each is measured by the hand of infinite Wisdom, and appointed to fulfil some useful end."

The grand and truly characteristic feature of Autumn, however, is the harvest. To this all the progress of the previous seasons has tended, and on its results all the rest may be said to depend. The harvest furnishes the food of the husbandman, and the seed by means of which fresh crops are to be obtained. It is the consummation of all the labours, and all the changes incidental to the other seasons of the year. For this, the farmer ploughs and sows in hope, and to it he looks for the reward of all his toil. Although, as we have seen, the autumnal labours of the farmer include some of those which we associate more consistently with the season of spring, yet the predominating ones are the reaping and gathering in of the fruits of the year; and all the feelings and thoughts most naturally suggested to the mind are in harmony with this.

In the concluding Canto of Spenser's "Faerie Queene,"

the poet introduces "Great Nature, ever young, yet full of eld," before whom appear her various subjects, and among the rest the seasons. After "lusty Spring" has been introduced:—

> Then came the jolly SUMMER, being dight
> In a thin silken cassock coloured greene,
> That was unlined all, to be more light:
> And on his head a garland well beseen,
> He wore, from which, as he had chaffed been,
> The sweat did drop: and in his hand he bore
> A bow and shafts, as he in forest greene
> Had hunted late the leopard or the boar,
> And now would bathe his limbs, with labour heated sore.
>
> Then came the AUTUMN, all in yellow clad,
> As though he joyed in his plenteous store,
> Laden with fruits that made him laugh, full glad
> That he had banished hunger, which before
> Had by the belly oft him pinched sore:
> Upon his head a wreath, that was enroll'd
> With ears of corn of every sort, he bore,
> And in his hand a sickle he did hold,
> To reap the ripened fruits the which the earth had yold.

Herein the poet most vigorously impersonates the season of harvest, with its abundant stores, and its joyous sense of plenteous fruits and grain, of hunger displaced by fullness, and apprehension and uncertainty by "the joy of harvest." Yet Autumn suggests other ideas to the thoughtful mind, as it progresses onward from the close of summer's heats to the late chills and frosts which warn us that the winter is at hand.

It is a period of ripeness and perfection, but there are also associated with it reflections which its mature beauty suggests, the sadder and more solemn thoughts connected with completion and decay. We entertain towards it a subdued sense of quiet enjoyment, in which the consciousness of realization supersedes the pleasureable anticipations of hope, but also we feel unavoidably forced to the conclusions connected with a period of de-

cline. The work of the year seems at an end; its spring and summer are all past, and its beauty is altogether such as we recognise in hale old age, when the business of life is nearly done, and the hopes which properly belong to it have no relation to the things of time. The spring is past, the summer is ended, and that only can now be reaped which the provident husbandman was careful to sow and tend during the earlier months of the year.

"Tears, idle tears, I know not what they mean,
Tears from the depth of some divine despair
Rise in the heart, and gather to the eyes,
In looking on the happy autumn-fields,
And thinking of the days that are no more.

Fresh as the first beam glittering on a sail,
That brings our friends up from the underwold,
Sad as the last which reddens over one
That sinks with all we love below the verge;
So sad, so fresh, the days that are no more."

So sings Tennyson in his quaint, beautiful poem of "the Princess," sweetly touching the thrilling chord with which memory links autumn's solemn gold and sombre hues, with remembrances of life's spring and summer-time forever past.

Far different, however, are the associations with which the fashionable and the gay delight to link the period of the fall of the leaf. We are all more or less the slaves of custom. The habits of society, the burdensome exactions of fashion, and the controlling influences of wealth and rank, all lay their grievous yoke upon us, which few indeed have the independent spirit and just sense of self-respect to throw from them. In the golden days of Queen Elizabeth, the dinner hour was at noon, and in summer at least, the hour of rest corresponded with that of departed day; but now all the dictates of nature appear to be despised. The man of fashion is scarcely out of bed at noon, and is only retiring to rest when the grey

dawn has brightened into sun-rise. And as in fashionable society night is thus turned into day, and the glorious and beautiful beams of the sun are exchanged for the heat and glare of candles and lamps; so too all the natural order of the seasons is reversed, and the man and woman of fashion now quit the country while the trees are still leafless, and the sweet green tints of spring have only begun to steal over the landscape, in order that they may spend the warm summer and the early autumn, in crowded assemblies, and in heated theatres and ball-rooms, unconscious of the thousand charms which nature then displays. But just as the genial weather of earlier autumn is beginning to give place, in September, to the chill mornings and evenings which admonish of approaching winter, the whole fashionable world takes flight from town, and now the sportsman enters on the enjoyment of the sole delight for which he conceives the country worth visiting. The murderous gun is heard on every hand; the partridge, the pheasant, and the pretty nimble hare, which have proved so destructive to the farmer, now fall a prey to the fashionable sportsman, and the idler finds for once a sufficient stimulus to exertion, in what are termed the sports of the field. It cannot, however, be concealed that a strong and rapidly increasing prejudice, is striking at the root of such fashionable sports. In a highly artificial state of society such as ours, where, for the most part, a densely crowded population is seen struggling for the means of subsistence, and obtaining with difficulty their daily bread, it is manifestly unbecoming and discreditable to the wealthiest, best-educated, and most influential classes of society, to seek to maintain by costly artificial means a state of things natural only to a thinly peopled and uncultivated country. Were this a luxury purchased only by an outlay of money, however much we might question the wisdom of those who purchase it at such a price, no one could reasonably complain if the wealthy

chose to expend their fortunes in securing such an object; but when it is notorious that the preserving of game is the fertile source of crime and degradation, of misery, injustice, and wide-spread discontent, no rightly constituted mind can fairly investigate the subject, and say that the object is in any degree worthy of the cost. No season passes without our jails being occupied with some of the trespassers of the game laws, and few seasons indeed transpire without the lists of crime on some of the circuits being aggravated by one or more cases of murder, arising out of conflicts between some rustic trespasser and the preservers of game. We cannot but hope that with the rapidly increasing sympathy between the higher and the lower classes, and the sounder principles of justice and philanthropy which our statesmen, nobles, and landed proprietors are assuming, that these mischievous game-laws, the relics of a long extinct feudal system, will be swept from our statute book, and that the sportsman will be content to pursue his game in their natural resorts among the wild highland moors and mountains of Scotland and Wales; unless he chooses to imitate some daring adventurers, and seek for more exhilarating sport on the pampas of America, or amid the vast unpeopled regions of Africa, where the lion watches for his prey beside the fountain at which the hunter slakes his thirst.

How striking is the contrast which is presented to the mind, between these associations with the close of the harvest season which we have just referred to, and those which more justly pertain to it. The incidents of the later autumn supply some of the most beautiful imagery employed by the sacred writers. "As for man," says the Psalmist, "his days are as grass; as a flower of the field so he flourisheth; for the wind passeth over it and it is gone; and the place thereof shall know it no more." Job, in his sorrow likens himself to the fallen leaf: a leaf driven to and fro, and Isaiah figuring forth our transitory state,

repeats the idea in varying forms. "Man fades as a leaf." "His glorious beauty is a fading flower;" he is "as an oak whose leaf fadeth, and as a garden that hath no water." The whole language of Scripture is full of expressive imagery drawn from nature. Much of its most touching beauty pictures forth the changes of the seasons, the varying incidents of the passing year, and the manifestations of the Divine goodness and fatherly care over the works of his hands: "He sendeth the springs into the valleys, which run among the hills. They give drink to every beast of the field: the wild asses quench their thirst. By them shall the fowls of the heaven have their habitation, which sing among the branches. He watereth the hills from his chambers; the earth is satisfied with the fruit of thy works. He causeth the grass to grow for the cattle, and herb for the service of man: that he may bring forth food out of the earth; and wine that maketh glad the heart of man, and oil to make his face to shine, and bread which strengtheneth man's heart. The trees of the Lord are full of sap; the cedars of Lebanon which he hath planted; where the birds make their nests; as for the stork, the fir-trees are her house. The high hills are a refuge for the wild goats, and the rocks for the conies. He appointed the moon for seasons; the sun knoweth his going down. Thou makest darkness, and it is night; wherein all the beasts of the forest do creep forth. The young lions roar after their prey, and seek their meat from God. The sun ariseth, they gather themselves together, and lay them down in their dens. Man goeth forth unto his work, and to his labour, until the evening. O Lord, how manifold are thy works! in wisdom hast Thou made them all: the earth is full of thy riches; so is this great and wide sea, wherein are things creeping innumerable, both small and great beasts. There go the ships; there is that leviathan, whom thou hast made to play therein. These wait

all upon thee, that thou mayest give them their meat in due season. That thou givest them they gather: thou openest thine hand, they are filled with good. Thou hidest thy face, they are troubled: thou takest away their breath, they die, and return to their dust. Thou sendest forth thy spirit, they are created; and thou renewest the face of the earth. The glory of the Lord shall endure for ever: the Lord shall rejoice in his works."

WINTER.

"Is it not so? The winter of the year;
The winter of our life; the winters all
Of the past ages; rolling on, appear
To swallow up, and cover with a pall
Our living summer-tides, and on their bier
Strew ashes: an untimely funeral
For which no drooping flowers their dew-cups rear,
Nor e'en funereal yew, the banquet hall
Of Death to deck and give the grave its cheer!
Is it not so?——It is not: o'er th' high wall
Steals the grey dawn-light; see! the morn is near;
Dig deep and fear not; 'tis Death's funeral:"

CHAPTER I.

THE SLEEP OF NATURE.

THE season of winter is at once the close and the commencement of the year. Like the natural sleep of man, and the night which succeeds to the day, it includes the closing period of rest after labour, and the awakening dawn of refreshment after repose. It is the termination of the past and the precursor of the future, and is therefore happily regarded as a transition-time for maturing strength, and planning fresh aggressions on the legitimate fields of human toil. It seems indeed to the heedless observer as a lost time, in which the rigorous season shuts up the husbandman from all the scenes of useful exertion, and compels the labourer to forego his industry. But it is not so. We have designated it the sleep of nature, and like the natural sleep of man, it is the invigorating season

on which the successful results of all the other portions of the year depend for the fruits of active and wisely employed labour. "He casteth forth his ice like morsels; who can stand before his cold? He sealeth up the hand of every man, that all men may know his work." The evidences of the power and goodness of the Almighty are not, however, the less apparent during the dreary and sterile reign of this, the closing season of the year. "The waters are hid as with a stone, and the face of the deep is frozen," but in this, the most remarkable chemical phenomenon of winter, some of the most important and beneficial laws of nature are manifested, and on its influences depend to a considerable extent the successful labours of the husbandman in the spring.

"Tired nature's sweet restorer, balmy sleep,"

is not altogether a passive agent in the restoration of the worn-out labourer. While the body reposes, and the mind is chained in healthful inactivity, or dallies with some pleasing fancy in its dreams, the restorative physical operations are busily at work: the blood is circulating through the frame, the lungs are fulfilling their important vital functions, the digestive organs are busy in their appointed task, and the slumberer arises in the morning a new man. So too with nature, after its winter's sleep. The expansive power of water when passing into the solid state of ice is well known. Scarcely any limits can be set to its force. It has been found capable of bursting a cannon filled with water, and plugged up so as to leave it no other means of expansion. It rends and splits huge masses of rock, bringing down the giant fragments of the lofty mountain cliffs into the valley below, and in arctic regions, frequently splitting ice-bound rocks with a noise like thunder. Precisely the same effect is produced on the smaller fragments of disintegrated rock and organic matter which unite to form the soil from whence vegetable

life draws its nourishment. The soil being saturated with moisture late in the autumn, is heaved up, and pulverised by the alternate expansion and contraction of frost and thaw, so as admirably to fit and prepare it for the reanimation of the whole vegetable kingdom in the spring. This, indeed, may be styled nature's ploughing. It is the process by which, over hill and valley, in wood and glen and copse, where no instrument of man is applied to aid or accelerate her operations, the soil is pulverised around the roots of the grass and herbage, and of the countless thousands of plants and trees which clothe the uncultivated face of nature, and provide the needful stores for the flocks and herds, as well as for the multitudes of animal and insect life. But for this annual operation of the frosts of winter, some of our best soils would remain nearly unproductive. Stiff loams especially, composed for the most part of an unctuous clay, present in their natural state great obstacles to the labours of the agriculturalist, and would appear, indeed, to be totally incapable of being turned to any useful account. Their extreme tenacity impedes alike the absorption and removal of excessive moisture during the continuance of rainy weather; while the effect of a protracted drought is to make them so tough and indurated, that a plant might almost as soon force its tender roots into the pores of a sandstone rock, as into the bed of hardened clay. With such a soil, however, the husbandman has only to enlist the keen winter's frosts into his service, to render it a valuable recipient of the tender seeds of spring. The plough is applied in the autumn with a direct view to the peculiarities of the soil. It is ploughed up into furrows, so as to expose the largest surface both to moisture and frost, and being then left to the operations of nature, the water is received into the soil, and as it is expanded in the process of freezing, it forces asunder the adhering particles of the clay, loosening, crumbling, and pulverising the whole, and rendering

it peculiarly fitted to receive the seed in spring. Nature may therefore be truly spoken of as refreshing herself with sleep during the apparently inactive winter months. She is not dead. Vital functions of the most essential character are at work, producing results on which all the future depends, when the re-awakened vitality of the animal and vegetable kingdoms shall be again in operation.

The wisdom and power of the Creator are no less remarkably apparent in the beneficial properties with which frost and snow are endowed, for the protection of the soil and its included plants against excessive cold. Few operations of nature are more remarkable than this. The ice binds up the soil in its iron grasp, and, being a slow conductor of heat, the frost is thereby prevented from extending far beneath the surface, so as to injure the tender fibres and roots of plants. Even when it does reach and envelope them, this counteracting influence still predominates, and holds the winter's frosts in check, preventing the temperature of the soil from falling below the freezing point. But still further beneficial contrivances become apparent in other operations of the winter's frost. Its influence extends to the air, as well as to the earth and water, and affects the exhaled moisture floating in clouds above the earth. The rain drops are accordingly frozen, and precipitated to the ground in the form of snow. The woolly flakes of snow, when examined under the microscope, are crystalized in minute forms of extreme beauty, and wrought with the utmost regularity. The hail also assumes a regular crystalized form, but of a totally different kind from the down-like snow which falls noiselessly on the earth. The latter is manifestly designed to drop without injury on the naked boughs and tender plants exposed to the storms of winter, and to cover the grass and herbs, and the young winter wheat,

with its winged flakes, without hurting their most fragile shoots, or disturbing the exposed soil in its fall. While the sudden hail of spring or summer dashes down occasionally in destructive masses, which injure, break, and destroy plants, and extensively damage the works of man; the snow-flake is twenty-four times lighter than water, and so drops on the face of nature like the downy coverlet spread by its mother over the cradle of the sleeping babe. This also operates still more beneficially in preventing the injurious influences of the frost on the soil, and on its enclosed plants and seeds, so that one of the first operations of the frost is thus to provide a defence against its own excess. The snow being a very imperfect conductor of heat, it does not readily descend below the freezing point, and thus the soil beneath is under the softest guardianship when its white covering is spread abroad to protect the tender seeds and bulbs, and the fresh roots of the lately germinated autumn seeds. The simplest experiment suffices to prove this, for if a portion of a field is swept bare of snow during a protracted frost, and after being thus exposed for a time to the full influence of the cold, it will be found that the frost has penetrated to a considerable depth, binding the whole in its iron grasp, while another portion of the same field, which has remained covered by the snow, will be totally unaffected by the frost an inch or two below the surface. The practical value of this will be still more apparent if the experiment is tried during very rigorous cold, on a field of autumn sown wheat. The plants in the part exposed will then be found blighted, and sometimes completely killed by the frost, while the remainder of the field has escaped the same noxious influence by means of its snowy covering.

By means of the same remarkable non-conducting property of snow, the natives of the arctic regions are able to

employ it as the material with which they construct their winter dwellings, and thus enroofed only with the embedded masses of frozen moisture, and with their windows glazed with blocks of ice, they survive the inclement season, amid all the horrors of a polar winter, and sleep comfortably, wrapped in their furs, on a bed constructed of the same material. Inured as he is to his icy climate, the Esquimaux enjoys a comfortable warmth beneath his dome of snow, and feels no envy of those who enjoy our temperate climates, or bask beneath the perpetual sunshine of southern latitudes.

Thus do we find the balance of nature harmoniously preserved amid the utmost diversity of changes, and no single law operating without its use. The long winter of the polar regions is followed by a brief but most vigorous spring and summer. Within a week after the melting of the snows of Iceland, the fields are green, and in less than a month most of the plants are at maturity, so that where the sleep of nature is most prolonged, she is seen to awaken with a proportionate vigour, and to hasten the accomplishment of the processes of vegetation during the brief season of activity that remains. The same is frequently seen, though in a less degree, in our own milder climate. Occasionally a cold, protracted spring, threatens to mar all the labours of the husbandman. The trees refrain from shooting forth their leaves, the cereal plants are arrested in their progress, and the season seems passing away without the development on which the realizing of all its hopes depends. But on a change of weather, and the supervening of a very few days of warmth, the compensating powers of nature become immediately apparent. A sudden burst of vegetation takes place, as if nature, by one great effort, sought to make up for lost time, and a very brief period suffices to restore the hopes of the most despondent. In this, also, we cannot fail to recognise a remarkable provision of the Creator, for meeting

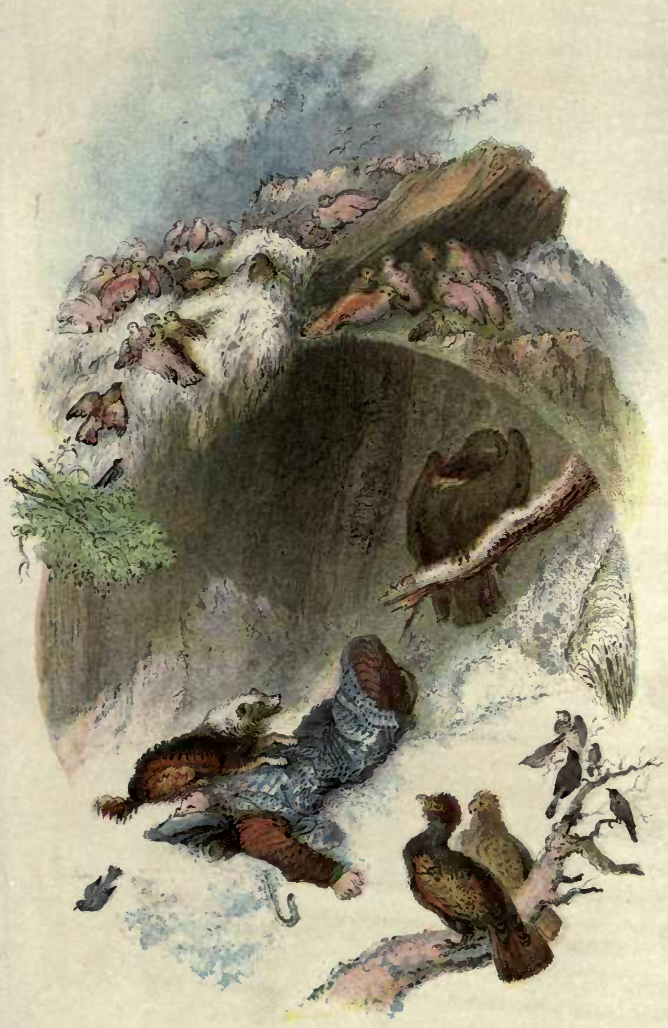
the peculiarities of a variable climate, and securing the fulfilment of the Harvest Covenant:

> "He marks the bounds which winter may not pass,
> And blunts his pointed fury; in its case,
> Russet and rude, folds up the tender germ
> Uninjured, with inimitable art;
> And, ere one flowery season fades and dies,
> Designs the blooming wonders of the next."

CHAPTER II.

VARIATIONS OF CLIMATE.

IN the great annual circle which the earth makes round the sun, its axis is inclined to the plane of the ecliptic at an angle of sixty-six degrees thirty minutes, and to this is owing the variety of seasons on its surface. The north pole points always to one spot in the heavens, and hence the facilities afforded to the navigator by an observance of the stars: the constellation of the great bear, with the pole star, affording him, in a clear night, a more unerring guide than the compass, which, as Columbus and many succeeding voyagers have found, is liable to err. In the northern hemisphere the north pole is inclined towards the sun during the summer, and thus the sun's rays fall on it within the arctic circle, and impinge on the whole surface within the temperate zone more directly, and in greater quantity. The day is also considerably longer than the night, while the sun remains in this relative position to the earth, and hence the heat accumulates, and produces the warmth of our summer and early autumn. In winter a precisely opposite result takes place; the north polar axis of the earth is then turned from the sun, so that his rays fall obliquely on the surface within the temperate zone, while the region around the pole remains in per-



WINTER.

petual night. Owing, also, to the slanting manner in which the rays of the sun fall towards our hemisphere in winter, a great proportion of them pass through the atmosphere without falling on the earth, and hence their influence is entirely lost. The same cause influences the relative duration of day and night, and the apparent position of the sun in the heavens, which in the summer appears to us to climb towards the zenith, while in the winter he travels through a smaller arc, and rises and sets considerably more to the south.

Such are the circumstances on which the succession of the seasons depends. It becomes an interesting inquiry to consider how far they appear to be ascribable to what we term accident, or in other words, the absence of design, or whether they are part of that plan of providence of which we have already traced so many proofs in considering the phenomena of the seasons. As might be anticipated from all that we have hitherto observed, the most remarkable proofs of mature design become obvious when we examine the effects dependent on the present inclination of the earth's poles, compared with what would result from its change. Had the earth's axis been perpendicular, there would have been no succession of seasons, and consequently the animal and vegetable life which are now maintained on, and which are nearly all so obviously adapted to the periodic changes which result from the inclination of the axis, must have almost entirely ceased. In Great Britain, the uniform highest temperature would never have exceeded that which occurs towards the close of the months of March and September, and which is totally insufficient to bring any of the fruits of the earth to maturity. To the north of this the temperature would have been proportionably less, and thus the greater part of the present habitable globe would have been rendered incapable of supporting living creatures, and could not even have been clothed in the stunted

vegetation of the brief Arctic summer. But it is not even by comparison alone that the present arrangement appears preferable to that which has been suggested as possible. The most careful investigations of scientific men lead to the conclusion that the present arrangement admits of the greatest possible diffusion of heat over the earth's surface, and hence adapts it for sustaining the largest amount of life. No argument deduced from nature can more clearly point to a wise designer having controlled and regulated the movements of our planet. Under other circumstances life might have existed in some regions, though the greater portion must have remained a sterile waste; but here we see that all its capabilities were considered, and that arrangement was finally adopted which proves most consistent with the adaptation of the planet to the maintenance of the largest number of living beings, and of the greatest amount of vegetable life suited to their gratification, and destined for their use.

By the combination of the spherical form of the earth with the inclination of its axis, all the varieties of temperature are produced, from the fervid heat of the torrid zone, to the perpetual winter of the poles; and this having been thus affected, we have seen how many proofs of wisdom are displayed in the adaptation of plants and animals to the various climates thus produced. Each region has its own plants and animals, which, for the most part, are found only capable of existing under nearly similar circumstances. Man alone ranges freely from the tropics to the poles. Yet he also is largely subject to the influences of climate, and we are enabled to trace to effects arising from the operations of our own temperate climate much of the development of those faculties which have placed a few of the nations of Europe foremost among the whole human race. Born within the torrid zone, surrounded by the abundant spontaneous productions of the soil, and burdened by the lassitude of a tropical climate,

man is found an indolent, degraded savage. In the frigid zones, bound down by the constant struggle with these inhospitable regions, and checked in the full development of the highest functions of the human intellect by the rigorous influences of the climate, man equally appears in a savage state; while in our happier temperate climate, we find privations enough to stimulate us to exertion, without stunting our mental or physical powers, or exhausting our whole energies in overcoming the difficulties of our situation. How much of this depends on the happy medium of our temperate climate is sufficiently manifested in our own common experience. When exposed during the brief period of extreme heat in summer, we are all conscious of an extreme lassitude which affects alike our bodily and mental faculties, and renders us incapable of employing them with good effect. Constantly exposed to such a temperature, we would be compelled, in some degree, to overcome the inclination to indolence, but it would only be effected by a constant struggle, and would be productive of few great results. Still more instructive is our experience under the opposite influence of cold. During a long ride, with the atmosphere at a low temperature, on the top of a stage-coach, or even in the more sheltered covering of a railway-carriage, most of our readers must have experienced the benumbing influence of continuous exposure to cold. Wrapped up with ordinary attention to the requirements of the season in our climate, there is not generally, under such circumstances, any acute sense of suffering, but only a general prostration both of the physical and mental powers. A total incapacity for continuous thought or intellectual pleasure of any kind, is frequently accompanied by a sense of hunger and thirst, generally quickened into greater acuteness from the absence of all other desires. This state of mind and body, which we only experience under such temporary exposure, may serve to show how

far we would be capable of any high intellectual enjoyment or continuous physical energy, in a climate which must constantly place us in the same physical state, and where the bodily frame must become so inured to the low temperature of the climate, that it could find sufficient shelter from the cold in a snow hut, where a strong heat kept up for any length of time would promote a rapid thaw of its walls, and bring the house about its owner in a flood of rain.

The love of country is a universal feeling, and we know well that the negro from the torrid wilds of Africa, and the Esquimaux from the icy plains of the Arctic circle, equally pine for their native home when transplanted to the regions of the temperate zone. So far indeed from envying us our privileges, each regards us as fit objects of their commiseration. Thus far Providence supplies to them, by virtue of contentment and the power of habit, a compensating influence, by which their happiness does in reality exceed that of thousands in our more favoured clime. Yet it cannot be overlooked that in the temperate zone, the mental as well as the physical powers of man expand with a vigour and freeness altogether unknown elsewhere. The cradle of the human race was indeed under milder skies, and the vast central plains of Asia may yet be destined anew to furnish the arena for flourishing empires, and the scenes of restored human happiness; but meanwhile it is within the northern temperate zone both of the old and new world, under changeable skies and a variable climate, but protected alike from the extremes of heat and cold, that man has found localities best suited alike to his physical constitution and the healthful development of his moral and intellectual faculties. The varieties of our climate have supplied a useful stimulus to industry, quickening the inventive faculties, and giving full play to ingenuity and wholesome competition, from the constant demands for clothing, and for household accom-

modation and furnishings suited to the alternations of the seasons. The ungenial climate which forbids the out-door sports and occupations of Italy or Spain, has helped to give the peculiarly domestic character to English life, and thus from the very rigour of our winter season the enjoyments and the virtues which encircle our social hearth have had their rise.

CHAPTER III.

HYBERNATION OF PLANTS.

WE have already seen that the changes on all living things which appear to depend on the annual course of the seasons, are not to be considered as solely induced by the differences of temperature, and the peculiar meteorological influences of the weather at the various periods of the year. To the careless or ignorant observer who refuses to recognise the evidences of design which the study of nature discloses on every hand, it may appear a sufficient mode of accounting for such changes as accompany the close of the year by assuming that the lessening temperature checks the growth of plants, diminishes the vigour of animal life, and thus prepares all nature for the wintry change; when, under the deadening influences of frost and snow, the withered leaves are stript from the trees, the flowers disappear from the gardens and the fields, and universal death seems to predominate. Very different, however, from this is the actual state of things. Not only do we find that the constitution both of plants and animals proves a manifest adaptation and adjustment to the annual cycle, but those of tropical climates are destitute of the provisions by which the natives of temperate and Arctic regions resist the cold of winter, and

conform to the successive changes of the year. Both plants and animals carry on the processes of reproduction in strict accordance with the annual changes of the year; and though the agency of heat and cold exercises considerable influence in modifying these, and the latter is sufficient in some cases to produce sterility, yet they are insufficient to obliterate all traces of the natural laws implanted in them in relation to their true localities and conditions of life. It has been found, for example, that our native fruit-trees when transplanted to southern latitudes, continue for a considerable time to flourish, irrespective of the seasons of their new locality, and to perform the functions of their northern summer in the winter of the country to which they have been introduced. The same is also seen in some plants transplanted to our own country, of which one of the most familiar examples may be adduced in the Cape heaths, and other similar plants brought from the southern hemisphere, which bloom during the period corresponding to their own summer, under our bleakest skies and most rigorous temperature.

By a remarkable process of nature, many animals, and nearly all plants, pass through the season of winter, in the regions exposed to severe cold, in a state of torpidity or sleep, to which we apply the term hybernation. In this state the plant may be described as entirely passive. The sap has ceased to flow; the leaves which performed so essential a vital function throughout the period of its active existence are gone, and so completely are all the functions of vitality suspended, that the full grown tree may be taken up at this period and removed to an entirely different locality without any injury, if the new soil to which it is transplanted be equally capable of supplying the nourishment requisite for its growth on the return of spring. Yet, though all active vitality is thus absent, the tree or plant is in a very different state during its period of hybernation from a dead plant. The

living principle, like the vital heat maintained in our own bodies while at rest or asleep, is sufficient to defend it from the effects of the keenest frost, to which a diseased or broken branch at once falls a sacrifice. This is shown by a very simple experiment. Before this period of inaction has succeeded to the healthful vigour of the summer and early autumn, the leaf and flower destined to burst forth on the return of spring have already been formed, and shut up within their enclosing shields or cases, they remain safely protected throughout the winter from its most biting keenness. Various provisions are apparent for effecting this. In some cases a succession of hard scales envelope it in their successive folds; in others, as in the willow, this is further protected by a downy covering, bearing considerable resemblance to the protecting wrappages within which some of the insects pass safely through a similar state of hybernation preparatory to the transformation of spring; while an additional protection is provided in the coating of thick resinous matter which may be observed exuding from the large buds of the horse chesnut, when they swell and prepare to burst in the spring. All these are so many devices for the secure protection of the bud, on which all the hopes of the coming season depend. Still, in addition to them all, the vital functions of the parent tree are indispensable for their safety. If one of these buds is severed from the tree, and left exposed to the frost for a single night, it is found to be hard and completely frozen through, while no frost has penetrated to those adhering to the tree. This, therefore, suffices to show the propriety with which we may apply to the state of vegetable hybernation, the term of winter's sleep. The evidence, moreover, of design, and of wise adaptation of means to an end, is more fully borne out on examining the processes of germination in tropical plants. In these no such bud protects the new leaf or flower, but it springs at once into

existence, as if fearless of any such dangers as those with which the hardier children of colder latitudes have to contend.

A curious additional evidence of the peculiar provision of nature for the safety of plants while in their wintry torpor is frequently shown on the occurrence of untimely frosts in spring. The sap which appears to resist the keenest frosts of winter, becomes greatly more susceptible of congelation after the circulation of the sap has begun, and the vital functions have once more resumed their activity. The buds and tender shoots are then peculiarly liable to be frost-bitten, and the promises of the orchard are very frequently blighted in a single night. The rich blossom drops off, before its functions have been completed by the pollen or fertilizing dust falling with fructifying power on the stigma, and communicating the productive principle to the undeveloped ovary. Yet so complete is the adjustment between the annual motion of our planet through its orbit and the complete course of progressive development and maturity of vegetable life, that these same delicate fruit-trees annually put forth their flower before the leaf, in the early and cold weeks of spring: preserving therein the habitude of the plants in the warmer climates from which they have been introduced within the last three centuries to our fruit gardens; and when again transplanted from thence to the orchards of British emigrants at the African Cape and other colonies in the southern hemisphere, the adherence to the same systematic process of annual development transfers the summer products of their vegetable year to the winter of their new locality, as if they shared with the emigrant in the fond remembrance of home, and survived only as strangers in a strange land.

As one of the most marked changes on the vegetable kingdom incident to the season of winter, we have already referred to the casting off of the leafy covering of the trees,

and this strictly pertains to the process of hybernation. By the absence of the leaves, the necessity ceases for the circulation of sap being kept up, and the process of absorption, by their means, of carbonic acid and moisture from the air, is necessarily arrested. One object, therefore, is thereby to secure the attainment of that passive state of vitality which has been assigned to the plant for a season, like the natural sleep of man and the lower animals. The other and scarcely less important object, is that the bare tree may thereby present its isolated branches to the storms of winter, like a ship under bare poles, instead of meeting the full fury of the tempest with all its canvass spread. One class of trees, however, we are familiar with, which retain their foliage throughout the winter. In these, however, including the whole pine family, we at once recognise additional proofs of contrivance and adaptation to the sphere for which they are peculiarly destined. Occupying as they do in their natural habitats, the wild mountain ranges of Norway, the cliffs and exposed steeps of the Scottish Highlands, or the rugged heights of the Alps, and the wildest and most northerly regions of the North American continent, the mere annual fall of the leaf at the close of autumn would but little subserve the purposes of protection from the tempest. They are like a forlorn hope placed on the outermost lines of the camp, and must be ready at all seasons to withstand an assault. In the localities which they occupy, no season passes without some tempest sweeping in fury through their mountain strongholds. We accordingly find that, instead of the broad leaved foliage which densely crowns the clustering branches of the oak and the beech, or clusters on the elm, they are provided with a thin wiry leaf, set along the boughs like the teeth of a comb, offering no broad surface to the tempest, but permitting the wind to sweep through its meshes with the least possible resistance. It is also well worthy of notice, that no other class of trees

take an equally firm hold of the soil. Even in the broad ornamental lawn, their long roots may be observed heaving up through the smooth turf, and spreading out on every hand, so as to give the tree an extended basis, and a wide stretch of hold, for the purpose of resisting the utmost violence of the tempest. These cannot be regarded otherwise than as obvious contrivances, purposely designed to meet the dangers of exposed situations, under inclement skies, where the vicissitudes of winter pertain to all seasons, and the storm gives brief warning of its approach.

By different processes, the safety of most herbs and smaller plants is secured. Some complete the course of their brief existence in a single season, and having matured and shed their seed, in its natural state it drops into the ground to lie passive till the genial warmth of spring awakes the vital principle within, and it quickens into life. Others which survive the winter, die down entirely, leaving only the root concealed in the ground, from whence new shoots put forth in the spring, like some burrowing animal venturing out, on the return of warmth, from its winter lair. Besides these, we have some few herbaceous plants which preserve the evidences of life throughout the rigour of winter, and even cheer our otherwise waste gardens with their buds and blossoms; and thus the ingenious gardener is able, as a skilful artist, to dispose among the summer plants and flowers of the parterre and pleasure grounds, the varied evergreens and winter flowering shrubs, so that the lawn shall have its natural adornments at Christmas as well as midsummer, and the spring come, not altogether as a vital contrast, but only as a welcome and most delightful change.

CHAPTER IV.

HYBERNATION OF INSECTS.

PROCEEDING from vegetable to animal life, we find a similar process of hybernation, or passive repose through the months of winter, pertaining to a large proportion of the insect tribes in a certain stage of their existence. Next to the vegetable characteristics of leaf and flower which denote the season of summer, or by their absence remind us that it too is gone, nothing is more characteristic of the period of vivifying warmth and maturity than the abundance of insect life. This cannot have escaped the notice of the rambler least familiar with the features of rural scenery. In the gipsy or pic-nic party on a warm day in summer, the numerous insects not only attract the eye, but become a subject frequently of serious annoyance. Innumerable flies buzz about, settling on the face and hands, and humming in the ear. Clouds of the gnat or midge dim the air, and frequently attack the skin, leaving an irritating sense of the power of annoyance possessed by such puny antagonists; the large beetle blindly dashes against the rambler with its noisy drone, and the bee, the butterfly, the wasp, and the dragon-fly, are all abroad, filling the on-looker with a sense of life, industry, and universal joy. No less busy is the ground beneath our feet. Seated in the newly mown hay-field, the ant, the grasshopper, the field-spider, and an endless variety of beetles, grubs, and creeping things are all busy around, so that the earth seems animated, and we are in sight of a world of sentient beings as busy, and far more numerous, than our own. But let the same rambler revisit the scene of former observation on some clear frosty winter day, when the sun is shining brightly but coldly, and the sharp frost has hardened the moist earth into a solid mass, how

great is the change! Every symptom of insect life is gone. They have vanished like the leaves of the summer trees; and no human power can recal one of all the myriads of insects so lately sporting in the beams of the same sun. But there is a Divine eye over all the works of nature, and the voice of spring will awaken to life the busy myriads of sporting insects, to evince anew the Divine goodness, wisdom, and power.

We have already referred to the successive stages of insect transformation, so that it is not needful to do more than to allude to them here. The endless varieties of insect eggs, laid by the parent insects in the summer, survive the winter, and their vital principles awaken under the same maturing influence which calls the whole vegetable kingdom into life. The chrysalis, in like manner, passes through the winter season in a dormant state, and, revived by the returning warmth, throws off its final shroud and assumes the form of a perfect insect. If we select as an illustration of the several examples of progressive insect transformation, the common gipsey moth, we shall see how admirably nature provides in various ways for the protection of the vital principle during the chill winter months in which the summer fly would inevitably perish. When about to lay her eggs, " the gipsey moth places herself on the trunk of an oak or an elm, invariably with her head downwards, the reason of which position will be immediately explained. Without the aid of her legs, which are too short to be used like those of the gnat by way of rule and compass, she contrives to place her eggs in the form of an inverted cone. She first makes a little bed of down, into which she thrusts the egg intended for the point of her cone; and this egg, being covered with adhesive gluten, attaches around it all the hairs of the down with which it comes in contact, and also sticks to the bark of the tree, from its being pushed home. Proceeding in the same manner, she continues for several

hours adding to the mass; but she does not in general finish the operation in less than two days, indulging in occasional rests when fatigued with her labour. At intervals, also, she takes care to protect the eggs placed in the cone with an exterior covering of the same down. There is one part of these operations not a little remarkable. In the bed which she first makes for the eggs, the hairs of the down either point at right angles to the bark of the tree, or at least are tossed down with little regularity; but in the external coping, which is designed to keep out the winter rains, the hairs are carefully placed in a sloping direction, like the tiles on a house, or the pile of a well brushed hat, pointing downwards towards the base of the cone." *

In this, however, as in most other works of animal instinct, a controlling intelligence is manifest in the proceedings of the parent, and occasional modifications in the form and construction of the groups of eggs are apparent, consequent on the nature of the locality where they are deposited, and the degree of protection requisite to protect them from external violence. "The eggs which are thus deposited with so much care, are destined to abide all the pitiless pelting of the storms of winter; for, although they are laid in August, they are not hatched till the elm comes into leaf in the following spring. The covering of down, accordingly, from the manner in which it is tiled and brushed smooth by the mother moth, not only protects them from wet, but from severe cold, being one of the best non-conductors of heat. The experiments of modern chemical philosophers have proved beyond a doubt, that the warmest material for clothing is not what imparts most heat to the body, but what best prevents the escape of the heat generated there. The feeling of cold, therefore, does not, as might be supposed, arise from anything positively cold, but solely from a deficiency of

* Insect Transformations, p. 80.

heat. On putting the hand, for example, on a piece of ice, the feeling of cold does not arise from cold given out by the ice to the hand, but from the heat which the ice takes from the hand, which heat can be actually traced in the water formed by the melting of the ice. But when the hand is laid upon wool, feathers, or down, these do not feel cold, because they do not carry off the heat of the skin so rapidly as the ice.

"It may appear a little paradoxical, though the doctrine is sound, to assert that down and similar materials are nearly as well calculated for protecting an animal from excessive outward heat as from severe cold. This, however, has been long well known as a fact to the Neapolitan peasantry, who convey snow from Mount Vesuvius to Naples in the summer for the purposes of luxury: they preserve it from melting by covering it with chaff and wool. It may not be out of place to remark that instances of this occur among insects, precisely similar to what we have just detailed respecting the gipsey moth. The brown-tail and the golden-tail moths, whose caterpillars spin themselves a warm nest before the setting-in of the winter colds, seem no less careful to protect their eggs from the summer heats of July and August, at which time they are deposited. The down with which they are furnished for this purpose grows upon the tail of the female moth, in form of a thick tuft or brush, of a shining silky gloss, and of a different colour from the short hair on the body."

Passing from this first stage in the vitality of insects, we have next to consider them in the state of grubs, maggots, or caterpillars, and here also no less efficient provisions for the endurance of the cold, and the absence of all sources of food, during winter, are apparent. Most of our readers must be familiar with the caterpillar of the tiger moth, commonly called, from its curious covering, the hairy caterpillar. This thick covering of

bristles or hairs is by no means peculiar to the tiger moth caterpillar, though it is the most marked example. Few caterpillars, indeed, are without some such covering, while in some of them it is found to increase on the approach of winter, so as to leave no doubt of its being designed as a covering and protection from the cold. The younger Huber has remarked, " The larvæ of some ants pass the winter heaped up in the lowermost floor of their dwelling. I have found, at this period, very small larvæ in the nests inhabited by the yellow ant, the field ant, and some other species. Those that are to pass the winter in this state are covered with hair, which is not the case in summer."

This is a provision for the season of winter with which all naturalists are familiar. It is this which gives so much value to the furs of animals brought from the cold northern regions of Europe and America, where, on the approach of winter, their hair is found to be thick and close, and in the best state for resisting the severe cold to which they are to be exposed. Other caterpillars, however, survive the winter though destitute of any such defence; and there can be no doubt that in all of them a special adaptation of the vital principle and the functions of the body must exist, altogether apart from this external coating: as we well know that no covering, however warm, would suffice to prolong the life of warm blooded animals under similar circumstances. The extreme hardiness of these insects, and their capacity of enduring cold are remarkable. " They are provided with no extraneous covering, farther than the occasional shelter they may obtain by crawling under withered leaves, the copings of walls, or the bend of a branch. Among these some are thickly covered with hair, of which we have an instance in the caterpillar of the great tiger moth; but a more remarkable example occurs in the caterpillar of the drinker moth, whose very feet are covered with fine shaggy down.

It is this, no doubt, which preserves it from becoming torpid during winter; and as it feeds on grass, it can always procure food during the severest weather. When a fine sunny day chances to break in upon the gloom of winter, this pretty insect may be often seen stretched at its full length on a low twig, or the withered stem of a nettle, basking in the sunshine with apparent delight. We kept one of them in our study during the winter of 1827–8; and it continued to feed sparingly till February, when, owing to neglect, it unfortunately died.

"There are several other caterpillars, however, which live during the winter, in a no less exposed manner, without being provided with any covering of hair; though some of these, we may remark, do not continue to feed, but become wholly or partially torpid, such as the caterpillar of the magpie moth. Of this species we have observed numbers, about as thick as a crow-quill, remaining in the same position for weeks together, and never moving, except when some very considerable change of temperature, either colder or hotter, took place. They do not seem to select the warmest places within their choice, being usually found on an exposed currant branch, or under the upper cross-bar of a paling. We observed one, during several months of the winter of 1828–9, stationary under the lintel of a door, where a continual current of air must have rendered it exceedingly cold. We have endeavoured to rouse some of these from their semi-torpidity by keeping them in a warm room; but though they would make a few lethargic and unwilling movements, none of them would eat, and the change always proved fatal."*

The transformation of the insect from this to its last transitional stage, and thence to the final state of a winged moth or butterfly, has already been described with sufficient fulness. In the chrysalis state, the further progress

* Insect Transformations, p. 193.

seems more dependent on temperature than at any other period of development. Some butterflies, such as the beautiful swallow-tailed butterfly, have two broods in a single season. The first of these passes into the chrysalis state in July, and changes from this to the perfect butterfly state within a fortnight, while the second brood, hatched in the autumn, retains its chrysalis state for nearly nine months, before the butterfly appears. If, however, the latter chrysalis be subjected to an artificial heat similar to that under which the former passes through its final transformation, it will assume the complete butterfly state in about the same time; and, if provided with food, will deposit its eggs before it dies. There is obviously, however, some controlling law of nature which prevents the awakening of insects from their state of torpidity during the winter, by a sudden and temporary rise of temperature. "The number of insects which hybernate in the perfect state is comparatively few. Of the brimstone butterfly, Mr. Stephens tells us the second brood appears in autumn, 'and of the latter,' he adds, 'many individuals of both sexes remain throughout the winter, and make their appearance on the first sunny day in spring. I have seen them sometimes so early as the middle of February.' The commonly perfect state of the wings in such cases might lead to the contrary conclusion, that the butterfly has just been evolved from its chrysalis. Several other species, however, chiefly of the genus *Vanessa*, do live through the winter in the perfect state; but this, as far as general observation extends, can only be affirmed of the female. Yet will insects bear almost incredible degrees of cold with impunity. Out of the multiplicity of instances of this on record we shall select two. In Newfoundland, Captain Buchan saw a lake, which in the evening was entirely still and frozen over, but as soon as the sun had dissolved the ice in the morning, it was all in a bustle of animation, in consequence, as was dis-

covered, of myriads of flies let loose, while many still remained 'infixed and frozen round.' A still stronger instance is mentioned by Ellis, in which a large black mass, like coal or peat upon the hearth, dissolved, when thrown upon the fire, into a cloud of mosquitoes.

"It has been remarked by most writers upon the torpidity of warm-blooded animals, that cold does not seem to be its only cause, and the same apparently holds in the case of insects. Bees, indeed, which remain semi-torpid during the winter, may be prematurely animated into activity by the occurrence of some days of extraordinary mildness in spring; but, what is not a little wonderful and inexplicable, they are not roused by much milder weather when it occurs before Christmas,—on the same principle, perhaps, that a man is more easily awakened after he has slept six or seven hours than in the earlier part of the night. Immediately after the first severe frost in the winter of 1829-30, we dug down into the lower chambers of a nest of the wood-ant, at Forest Hill, Kent, which we had thatched thickly with fern-leaves the preceding November, both to mark the spot and to protect the ants in winter. About two feet deep we found the little colonists all huddled up in contiguous separate chambers, quite motionless till they were exposed to the warm sunshine, when they began to drag themselves sluggishly and reluctantly along. Even upon bringing some of them into a warm room, they did not awaken into summer activity, but remained lethargic, unwilling to move, and refusing to eat, and continued in the same state of semi-torpidity till their brethren in the woods began to bestir themselves to repair the damages caused by the winter storms in the outworks of their encampments."

We perceive, therefore, in an immense variety of instances, the same characteristics of a wise accommodation of the instincts and functions of the insect tribes to the other laws of nature. Not by a mere result of chance, or

accidental coincidence, but as the fruits of an all-comprehensive oversight and providential care, do we see a perfect harmony reigning throughout all the various manifestations of creative power, reconciling the changing seasons with the development of animal and vegetable life, and uniting all the varied phenomena of nature into one consistent whole.

CHAPTER V.

WINTER MIGRATIONS.

We have already noticed the autumnal migration of birds, by which so many of the natives of our groves and woods, which build their nests, and rear their annual broods among us, and cheer us with their spring and summer song, suddenly take their departure before the cold of winter sets in, to pass that season under milder skies. In lieu of these, however, we have other visiters, the natives of the bleak regions of the north, to whom our mild winters are a pleasant and genial change from the fierceness of the season under polar skies. The immense flocks of the wild geese winging their way to the southward, supplied to Sir John Franklin one of the first warnings that the season of action was at an end, and that he must prepare for the polar winter closing in upon him. Throughout the whole north the various birds of the genus *Anas* abound, and exhibit many remarkable evidences of the wise provisions of nature for resisting the influences of the low temperature to which they are exposed in their native haunts. "The swan, with its stately plumage, frequents chiefly the inland seas and lakes, of which it has been called the peaceful monarch. The goose, a less elegant but more valuable bird, migrates in vast numbers every

spring to breed on the Arctic shores and islands, and affords a valuable supply of food to all the northern settlements. The Hudson's Bay Company salt three or four thousand annually for winter. The Indians celebrate the month of their arrival under the title of the goose-moon. The duck reaches a still higher latitude than the goose, and endures still severer cold. Great flocks of that species called the eider arrive in spring on the most northern shores of Greenland. All the birds that fly over the frozen seas are provided by nature with a rich and ample plumage, and a lining of soft down beneath; and the people of those countries find their skins, with the feathers inside, to be one of their most comfortable articles of clothing. But the down of all the other species is surpassed in fineness by that of the duck now named, the delicious softness of which fits it for the couch of kings. A pound of eider-down, according to Sir Charles Giesecke, is usually sold for a pound sterling. The best is that which the birds pluck from their breast to furnish the interior of their nest. The Greenlander, watching his time, removes this precious lining as soon as it is completed, whereupon the poor animals form a second, destined to share the same fate.

"Among Arctic birds are included the terns, which on the American coast are so very numerous, that an island has been named from the immense flocks with which it is annually filled. They produce the most delicate eggs of any water-fowl. We may add the guillemot, whose skin affords a peculiarly comfortable clothing,—the sandpiper,—the plover,—the grouse and ptarmigan, of which a species, much valued on account of the delicacy of its flesh, occupies the interior of Greenland. All ptarmigans change their colour, from mottled gray or brown in summer to pure white during the winter months. According to De Reste, the dark summer-covering is shed at the end of autumn, and a new plumage shoots out, which

is white, till darkened by the warmth of the following spring, or, to speak more accurately, a partial moult takes place towards the close of the year, during which all the coloured feathers are thrown out, and their places supplied by white ones; while in spring most of these last are again shed, to make room for others adorned by the richer and more varied hues of summer. Captain Parry saw this change go on so rapidly among the grouse on Melville Island as to be perceptible from day to day." *

The whole of these natives of the icy North, after having reared their young, proceed to some southern region about the middle of autumn, and of those a portion arrive in our islands, and replace in some degree our own native deserters.

The majority of these winter visiters are aquatic fresh-water or sea fowls, and haunt our coasts, or frequent the inland lakes, fens, and marshes. They cannot, however, with strict propriety, be regarded as natives of our country, though as regularly found in it as any of our spring nest-builders; for scarcely any of them remain with us to lay their eggs, or hatch their young. Nearly the whole of them abandon our shores previous to the commencement of the breeding season, and perform the work of incubation in the colder regions of the north, where, when the rigour of winter begins to pass away, an abundant supply of food is constantly to be found.

The quadrupeds of the Polar Regions display a similar instinct in migrating to the southward preparatory to the setting in of the winter; though some few of the hardiest natives of these inhospitable regions appear to be capable of enduring the rigour of a northern winter, and securing the needful supplies of food even amid the long unbroken night that prevails within the Arctic circle, while others pass through the same period, partly by hybernating in a manner not greatly dissimilar from that already described

* Polar Seas and Regions, p. 101.

in the habits of certain caterpillars and insects. "In caves, or in the hollows of the ice, dwells the most formidable of Arctic quadrupeds, the Greenland bear. This tyrant of the cliffs and snows unites the strength of the lion with the untameable fierceness of the hyena. A long shaggy covering of white soft hair and a copious supply of fat enable him to defy the winter of this rigorous climate. Hence, when exposed even to the moderate heat of Britain, he appears to labour under great uneasiness. Pennant saw one, over which it was necessary, from time to time, to pour large pailfuls of water. Another, kept for some years by Professor Jameson, evidently suffered severely from the comparative warmth of an Edinburgh summer. The haunt of this voracious inhabitant of the Polar regions is on the frozen shore, or on mountains of ice, sometimes two hundred miles from land; yet he is not, strictly speaking, amphibious. He cannot remain under water above a few moments, and he makes his way to sea, only by swimming from one icy fragment to another. Mr. Scoresby limits his powers in this respect to three or four miles; yet Parry found one in the centre of Barrow's Strait, where it was forty miles across. His prey consists chiefly of the smaller cetacea and of seals, which, unable to contend with him, shun their fate by keeping strict watch, and plunging into the deep waters. With the walrus he wages a fierce and doubtful war; and that powerful animal, with his enormous tusks, frequently beats him off with great damage. The whale he dares not attack, but watches anxiously for the huge carcass in a dead state, which affords him a prolonged and delicious feast. He scents it at the distance of miles. All these sources of supply being precarious, he is sometimes left for weeks without food, and the fury of his hunger then becomes tremendous. At such periods man, viewed by him always as his prey, is attacked with peculiar fierceness." *

* Polar Seas and Regions. p. 89.

The strength and voracity of the tiger appear to be fully equalled by this native of the north, and the narratives of northern navigation abound with incidents of perilous encounters sustained with it. "Though the voracity of this savage creature is such that he has been known to feed on his own species, yet maternal tenderness is as conspicuous in the female as in other inhabitants of the frozen regions. There is no exertion which she will not make for the supply of her progeny. A she-bear, with her two cubs, being hunted by some sailors across a field of ice, and finding that, neither by example nor by a peculiar voice and action, she could urge them to the requisite speed, applied her paws and pitched them alternately forward. The little creatures, as she came up, threw themselves before her to receive the impulse, and thus both she and they escaped from danger.

"None of the varieties, indeed, are devoid of intelligence; while their schemes for entrapping seals and other animals on which they feed often display considerable ingenuity. The manner in which the Polar bear surprises his victim is thus described by Captain Lyon:—On seeing his intended prey he gets quietly into the water, and swims to a leeward position, from whence, by frequent short dives, he silently makes his approaches, and so arranges his distance, that at the last dive he comes to the spot where the seal is lying. If the poor animal attempts to escape by rolling into the water, he falls into the paws of his enemy; if, on the contrary, he lies still, his destroyer makes a powerful spring, kills him on the ice, and devours him at leisure. Some sailors, endeavouring to catch a bear, placed the noose of a rope under the snow, baited with a piece of whale's flesh. He, however, contrived, three successive times, to push the noose aside, and, unhurt, to carry off the bait. Captain Scoresby had half tamed two cubs, which used even to walk the deck; but they showed themselves always restless under this

confinement, and finally sought relief in their native element.

"According to Pennant and other writers, the bear forms chambers in the great ice-mountains, where he sleeps during the long Arctic night, undisturbed by the roar of the tempest; but this regular hibernation is doubted by many recent observers. The fact seems to be, that the males roam about all winter in search of prey, not being under the same necessity of submitting to the torpid state as the black bear of America, which feeds chiefly on vegetables; but the females, who are usually pregnant in the more rigorous season, seclude themselves nearly the whole time in their dens.

"The animals which belong entirely to the land, and feed on herbage, are, in a climate covered with snow nine months in the year, necessarily few both in number and species. The rein-deer, a most patient and useful creature, an inhabitant of the Polar regions, may be said to subsist as far north as animal life can be maintained. To the Laplander he is all in all; and in that dreary portion of the globe he can always dig from under the snow the moss or lichen, his favourite food. Even in the severer climates he carries his summer excursions as far as men have yet penetrated; but at the end of October the intense frost no longer allows him to reach even the simple pasture in which he delights. It is then that large herds are observed to assemble and migrate to the southward. From Melville Island they were seen crossing the frozen surface of the sea, to gain a milder climate on the American shore. The people within the Arctic zone do not tame the rein-deer, nor yoke it in the sledge; it is not even for them the staff of life; but it affords a favourite object of summer hunting, gives an agreeable variety to their meals, and yields their warmest and most valuable winter robes. The fur skin becomes always richer and more copious in proportion to the intensity of the cold,

against which it forms the only defence. In the chase the deer fall easy victims, even to the rude archery of the Esquimaux, being so simple and curious, that if a man merely walks away from them they follow. Some of these animals, which joined Captain Parry's crews on Melville Island, played round them like lapdogs, and at setting out in the morning used to gambol by rearing on their hind legs. The musk-ox, the only member of the bovine species which penetrates the Arctic zone, though in smaller numbers, constitutes also a wholesome food. Its unwieldy form is protected from the cold by an immense profusion of hair, which envelopes its whole limbs and figure, and also by an interior layer of wool, that appeared to Pennant the finest he had ever seen, and made, he was told, stockings superior to the richest silk. This last, is most probably a temporary winter clothing.

"The canine race presents several species which brave the most extreme severity of cold, and remain after every other land quadruped, except the bear, has taken its flight to the southward. Wolves, in considerable numbers, continue to seek their prey in the utmost depths of the Polar winter. It seems difficult to discover what food they find at that season; but a regular pack attended the English discovery ships, watching for whatever offal might be found exposed, and serenading them with nightly howlings. As if by a sort of tacit convention, they did not presume to attack the sailors; but they advanced in the most daring manner to the sides of the vessels, and sometimes even entered the huts of the Esquimaux, whose dogs they esteemed a regular prize, and very speedily devoured them. The natives catch them by traps formed of little sheds of ice, at the entrance of which is a portcullis of the same material, connected in such a manner with the bait within, that when the latter is seized by the animal the suspended portion drops, and the wolf is taken. Their tenacity of life is such, that

after apparent death they often revive and occasion danger. The Arctic fox, a small beautiful white animal, with woolly hair like a little shock-dog, occurs in still greater numbers. About a hundred were caught in Captain Parry's second voyage, some of which were half tamed and made pets of; while others, by a harder fate, were dressed for table; and their flesh, somewhat resembling kid, afford an agreeable relief from the constant use of salted meat."*

When Captain Parry saw the sun finally set for the season, leaving him and his crew shut in for the long winter, amid the frozen waters surrounding the group to which he gave the name of the North Georgian Islands, the almost total disappearance of every living thing greatly added to the general sense of desolation. "The animal tribes withdrew early in the winter. The officers, on the 15th October, made a shooting excursion, enjoying a very fine day, though with the thermometer forty-seven degrees below the freezing-point; but they did not find a deer, a grouse, nor any creature that could be ranked as game. All of them, deserting this wintry realm, had crossed the seas to America. There remained only a pack of wolves, which serenaded the crews nightly, not venturing to attack, but contriving to avoid being captured. A beautiful white fox was caught and made a pet of. On the 12th May one of the men gave notice that he had seen a ptarmigan; and attention being thus excited, Mr. Beverley next morning shot one, and on the 15th three coveys presented themselves. The footsteps of deer were also seen, which, from the impression made on the snow, seemed to be moving northwards. From this time ptarmigans were supplied in considerable numbers; but they were made strictly a common good, being divided equally among the crew, with only a preference in favour of the sick."

* Polar Seas and Regions, p. 92.

In all these periodical migrations, the end in view appears to be the securing of the needful supplies of food, and the removal to a locality where the nature of the country, as well as the prevailing temperature, shall be found best suited to the fulfilment of the instincts and functions of reproduction. Other circumstances appear also occasionally to compel animals to migrate from their usual winter haunts. Dr. Richardson has remarked a singular circumstance with regard to the American black bear. "In general, this species hybernates in the northern parts of the fur countries; but it has been observed in certain years, and very severe winters, that great numbers enter the United States from the northward. These were all lean, and generally males. The natives assert, that a bear that is not fat cannot hybernate; therefore, those that have not acquired sufficient fat when winter overtakes them, necessarily emigrate to a milder climate."

We perceive in all these varied examples, an instinct superior to the wise suggestions of reason, guiding the migrating animals in a way directed alike for the preservation of their own species, and for the distribution of the needful supplies of food to numerous varieties of predaceous animals, and to man himself.

CHAPTER VI.

ASPECTS OF WINTER.

THE ideal characteristics of this season are, for the most part, monotonous and uninviting, and some of the most prominent of them harsh and repulsive. The painter pictures a lean and bearded old man, shivering before the smouldering embers of an ineffectual fire; and the sculptor has, with similar appliances of his art, sought to personify it by one struggling to retain the garment which its cold blasts are tearing from him. In the bleak and frozen north, where the light of the sun disappears, and

animal and vegetable life alike seem to vanish, as if extinguished in the long night of its winter, scarcely any picture can exaggerate the dreariness of the season, notwithstanding the brilliant meteorological phenomena which light up its skies. In our own temperate climate, however, this season assumes no such terrible aspect. Monotonous it is, inanimate, sterile, and bleak, when compared with the previous seasons; but to the observant and studious eye it also has its more genial phases, and its seeming monotony gives place to varieties not greatly less striking than those which have attracted our attention in the brilliant months of summer, or the fruitful maturity of the harvest-tide.

Spenser, in the personification of the seasons, already referred to, which he has introduced in the Seventh Canto of the "Faerie Queene," thus pictures Winter in all the most forbidding characteristics of the season of ice and snow:—

> "Lastly came Winter, clothed all in frize,
> Chattering his teeth for cold that did him chill;
> Whilst on his hoary beard his breath did freeze,
> And the dull drops that from his purple bill
> As from a limbeck did adown distill.
> In his right hand a tipped staff he held,
> With which his feeble steps he stayed still;
> For he was faint with cold, and weak with eld,
> That scarce his loosed limbs he able was to wield."

Here, we perceive, the poet has laid hold on the most prominent and universally recognised characteristics of the season, and employed them with artistic skill, so as to produce a picture which, in its one-sided truthfulness, approaches almost to caricature. The helpless imbecility of old Winter, with chattering teeth, and the drop frozen at his purpled nose, excites fully as much the sense of ridicule as of sympathy; though the feeling is but momentary, redeemed as these bold touches are by the vigorous verisimilitude of the whole. In the same

noble allegory, however, the poet goes on to represent the marshalling of the successive months before Nature, and in these he touches with the same master-hand the minuter characteristics by which the apparent monotony of Winter is relieved. After describing September marching on foot, "heavy laden with the spoil of harvest riches:" and October full of merry glee, with the products of the vintage and the malting, whose taste made him so frolicsome and full of lust, while he bears in his hand the zodiacal sign of the balance with which he justly dispenses the harvest fruits: he then employs the same vigorous pen to sketch the months of Winter; the first of them with the jovial look of one who is a sharer in the fruits of the ingathered harvest:—

> "Next was November; he full gross and fat
> As fed with lard, and that right well might seem;
> For he had been a fattening hogs of late,
> That yet his brows with sweat did reek and steam,
> And yet the season was full sharp and breem;
> In planting eke he took no small delight:
> Whereon he rode, not easy was to deem,
> For it a dreadful centaur was in sight,
> The seed of Saturne and fair Nais, Chiron hight.
>
> And after him came next the chill December:
> Yet he, through merry feasting which he made
> And great bonfires, did not the cold remember,
> His Saviour's birth his mind so much did glad.
> Upon a shaggy bearded goat he rade,
> The same wherewith Dan Jove in tender years,
> They say, was nourished by the Idan maid;
> And in his hand a broad deep bowl he bears,
> Of which he freely drinks an health to all his peers.
>
> Then came old January, wrapped well
> In many weeds to keep the cold away;
> Yet did he quake and quiver like to quell,
> And blow his nails to warm them if he may;
> For they were numb'd with holding all the day
> An hatchet keen, with which he felled wood,
> And from the trees did lop the needless spray:
> Upon an huge great earth-pot stone he stood,
> From whose wide mouth there flowed forth the Roman flood.

Here we perceive with what admirable truthfulness the poet has caught the most prominent characteristics amid the boundless variety of nature, which is little less manifest in the sterile repose of winter, than when the prolific summer is full with life, and hastening onward to give place to the teeming autumn. November appears busied in preparing his live-stock to be in a condition for furnishing his winter supplies, and delighting himself with the labours of the planter. The facilities for transplanting even the largest trees at this season, when the flow of sap has ceased, have already been referred to. The leafless shrubs and trees when despoiled of their beauty are thus transferred to new scenes, to add to them fresh charms, when they renew their foliage in the spring. Yet even in winter the trees cannot properly be said to be despoiled of all their beauty. Jesse, for example, thus vividly describes the familiar appearance of the beech in winter:—"Its leaves have now been shed, except those on some of the lower scrubby branches, which generally remain till the succeeding spring. Its trunk may then be seen, smooth in many places, and appearing highly polished. Some I have seen standing to a height of forty or fifty feet from the ground to the first branch, looking like stately columns of marble. This has been the case where the trees have been thickly planted together. In general, however, the trunk of the beech is short, but of great thickness; it is impossible to see it without being struck with the effect it produces in forest scenery. The little, slight, and pendulous branches which almost sweep the ground, are full of grace and lightness. When covered with a hoar frost they appear to great advantage. The beech has been called the Hercules and Adonis of our woods. Except perhaps those at Knowle and Burnham, there are few places where so many fine beeches are to be met with as in the Park and enclosures of Windsor. They will amply repay the student of nature for the

search necessary to find them out in many secluded haunts—

'In Windsor's groves your easy hours employ.'

"The lovers of woodland scenery, and especially the admirers of this my favourite tree, will not find my descriptions exaggerated. Mr. White, of Selborne, calls them 'the most lovely of forest trees,' and other writers have dwelt on their grace and beauty. Many of the trunks are studded with projecting knobs and other excrescences, and sometimes appear fluted or grooved. There is something also in the bark which is favourable to the growth of various mosses and lichens, which contrast well with the colour of the bark. The roots of the trees, too, are thrown out with great boldness, and when they appear above the ground, are generally covered with mosses of a beautiful soft green, differing in shade from those on the stem. When in this state they are fine studies for a painter, especially when their brown or glowing orange foliage is contrasted with the more lasting green of the oak."*

In this season, also, the foliage of the varieties of pine and fir, and the numerous smaller evergreens, attracts us by their persistence in the absence of nearly all other verdure, and mingling their dark clustering leaves with their disrobed companions of the grove, they give a peculiar charm to the winter landscape. No less characteristic and acceptable is the glistening and prickly holly, with its beautiful clusters of red berries, shining out brightly amid the Christmas snows. Spenser has not forgotten the merry-feastings and bonfires of Christmas time, which are not less heartily celebrated in Scotland than in England, though in the former country the religious services by which that ancient festival of the Christian Church has been celebrated through so many centuries are now abjured. The winter, indeed, is robbed of all its terrors

* Jesse's Scenes and Tales of Country Life, p. 37.

in our comparatively temperate and mild climate, when it associates the happy domestic circle round the warm hearth, and gives a zest to the joys of friendly intercourse. Then it is that the book lends its highest interest to the cheerful evening party, and that converse and music, with all the pleasant and genial fireside pastimes of youth, or the elegant accomplishments of feminine skill and ingenuity, yield their most welcome delights. Amid the happy enjoyment of domestic life, and the true appreciation of the virtues and the joys of home, so peculiarly pertaining to the people of our own favoured land, winter is welcomed with a satisfaction little less hearty and unalloyed than the genial summer; and prepared as we then are for the utmost violence of the season, no period of the year brings with it fewer disappointments. Still it is not to be overlooked that to the poor the winter is a season of many severe privations. This also the poet has not failed to mark, though passingly, in his personification of January "wrapped in many weeds to keep the cold away." It is an idea which many poets have given expression to; but scarcely has it ever been touched with more concise and life-like truthfulness than by the poet Burns. Described in the forcible, but very partially understood, language of a provincial dialect, it has nevertheless been felt and appreciated by thousands, as speaking home to the hearts of all men:—

"Listening, the doors an' winnocks rattle,
I thought me on the ouric cattle,
Or silly sheep, wha bide this brattle
O' winter war,
And through the drift, deep-lairing sprattle
Beneath a scar.

Ilk happing bird, wee, helpless thing,
That, in the merry months o' spring,
Delighted me to hear thee sing,
What comes o' thee?
Whare wilt thou cow'r thy chittering wing,
An close thy e'e?

It is a just reflection which many have been led to make, that happiness is very equally distributed throughout the various ranks of life. The observation of the degree of happiness enjoyed in the most diverse situations is well calculated to teach that high virtue of contentment, on which, so much more than on any amount of wealth, or rank, or any external circumstances, true happiness depends. The lot of the poet Burns was one of poverty and care, yet after all, the poet Byron was born to rank, wealth, and all the advantages which spring from the highest social position in life, and few indeed will hesitate to assign to him the sadder lot of the two. But while we recognise in all its force the value of this providential manifestation of care over us all, we cannot overlook the fact, that to the very poor the winter brings with it many sources of care and suffering. The lower animals are destined each for their several geographical localities and peculiar climates, and are physically adapted to the temperature of their native climes. The white bear encased in his covering of fat, and his warm coat of fur, roams fearlessly through the polar regions, amid their sunless ice and snows, and suffers nearly as much from exposure to the warmth of our temperate and very variable climate as any native of our shores would do from the piercing rigour of a Polar winter. So, in like manner, we see the wild-goose, swan, and many other birds migrating to the Polar regions to build their nests amid the exposed coasts and perpetual ice of these inhospitable regions. All animals and vegetables are, in fact, providentially adapted to a peculiar geographical localization, and can only be very partially severed from the scenes thus designed for their natural occupation, unless aided by the fostering care and persevering ingenuity of man. He himself, however, appears altogether differently constituted. Of all living beings he is the least provided with any offensive or defensive appliances, either for protection from assail-

ants, or for resisting the influences of climate, change of temperature, and the varying vicissitudes of the seasons. He is, moreover, exposed to a prolonged infancy and childhood, the helplessness of which far exceeds that of nearly all other living creatures, while its duration is protracted to a period exceeding the whole term of life of many of the inferior animals. The reasons for this are sufficiently obvious. The maturity to which man does attain is something vastly different, not in degree only, but in kind, from that of the most intelligent among the lower orders of animate nature. We wonder indeed at the sagacity of the dog, and the half-reasoning instinct of the elephant, but what after all are these, when compared to the intelligence of the talking, reasoning, thinking child, already beginning to ask strange questions as to whence it came, and whither it is going; and puzzling its elders by a curious inquisitiveness, that demands a reason for things which the wisest of them are as little able to answer as itself? Is it not, therefore, with a great end in view that the slow years of infancy and youth bear the man-child onward towards maturity? His moral and intellectual faculties are ripening for great ends, while all the holiest affections of our nature take their rise from the feebleness, the helplessness, and the confiding dependence of childhood.

But not only does man thus enter on life in so helpless and dependent a state that he could not survive for many hours if deprived of the tender watchfulness and solicitude of maternal affection; he also is altogether unprovided with any sort of natural clothing such as all the inferior animals possess. Thus, helpless, unarmed, and apparently incapable of coping with the slightest obstacle, man is placed amid a thousand difficulties and dangers, and surmounts them all. In the stead of all the natural appliances of the brute creation, he is provided with an intelligent reason, and by its means he clothes, arms, and

houses himself, and successfully asserts his dominion over every living thing. He, of all, is least capable of resisting the vicissitudes of the seasons, and hence spring the domestic arts, spinning, sewing, weaving; the adaptation of the hemp and flax, and the down of the cotton plant; the wool of the sheep; the web of the silk worm, and the thousand other appliances of human skill and ingenuity. Thence also spring the labours of the miner; the ingenuity of the builder and the architect; the uses—altogether peculiar to man—of fire, artificial light, and the still more complicated results of mechanical science and ingenious skill. Were we to follow out all the results which thus naturally flow from the inferior physical and greater intellectual endowments of man, we should find the theme inexhaustible. It is this very physical helplessness which prevents him from sinking into the mere isolated savage. He is thus enabled to brave all climates, and to pass with little dread from the sultry banks of the Ganges to the icy shores of Greenland, or the whale-haunted waters of Davis' Straits. In this also originate nearly all the commercial relations which bind so many nations together by the strong tie of a common interest.

The cave or the rude hut serves man in a primitive stage of society for a sufficient shelter, and the undressed skins, the spoils of the chase, suffice for needful clothing; but his wants increase with the refinement which civilization effects, until at length the east and the west, the north and the south, are each dependent on the others for an exchange of their commodities; all climates and all countries contribute towards the increasing demand, and thus the nations are linked together in the relationship which justly pertains to the descendants from a common stock, and the members of the one human family.

To the same source we have also to look for the vast changes effected on many parts of the earth's surface by means of agriculture. The dawn of British history dis-

closes to us the rude natives of the British islands, housed in huts, living by means of the chase, and clothed, armed, and in all things provided nearly as were the savage natives of the Polynesian islands when discovered by Europeans in the eighteenth century. How marvellous is the change which has since been wrought! The very climate has been changed by the hewing down of forests, the draining of marshes, and the conquests of agriculture over savage nature. The native plants probably scarcely furnished a single object worth gathering by the hungry Briton. Now we have the pear, the cherry, the plum, the peach, the mulberry, and the walnut, nearly all natives of the same east from whence the old nomade Briton himself came. Some of these are from Persia, more from Syria and Asia Minor. Thence also come the still more valuable cereal plants; while America has contributed the potato; and still more largely our commercial fleets, like great harvest wains, bring us the spoils of the world's autumn to enrich our stores. China sends her teas, India her spices and her rice; the east and west unite to supply us with sugar and coffee; and thus the produce of the sunniest climates comes to be spread out for our use under our own variable and humid skies.

Thus it is when we come to search into the final consequences of things that we find apparent evils may prove to be productive of the highest blessings. The varying temperature of the earth, the gradual transitions from torrid, and temperate, to arctic and antarctic regions, are thus seen to contribute to the wisest and most beneficent results for the use of man. Were the whole earth one uniform and temperate climate, where no winter supervened, but, like some of the isles of the Atlantic, there reigned a perpetual spring, we thus see that it would contribute little to the happiness of man. The intercourse of nations would be at an end when they had nothing to exchange; the great highway of the nations would be an

untravelled solitude if the fleets of commerce could procure only, by crossing the ocean, that which was already possessed at home; and thus man would be in his highest state what now he is in his lowest, an isolated being, bound by no other ties to his fellow men save those which lead the inferior animals to seek a mate, or congregate together in gregarious herds.

We thus see that man is adapted alike by his intellectual faculties and by his physical constitution for varying seasons, and the extremes of geographical change. He can accommodate himself to all changes and nearly to all climates, and this the more readily from his naturally helpless state which rendered him dependent on artificial means for protection alike from heat and cold. To all these evidences of the power of accommodation of the human frame to the variations of climate and temperature, there are certain manifest limits. The native of the Polar regions is dwarfed in his growth, and his intellectual vigour appears nearly as much stunted as his physical development. The extremes indeed, both of heat and cold, seem equally influential in retarding the full development of the mental powers, and in the history of nations we find, with few exceptions, that civilization, with all its attendant blessings, has had its birth in climes little exposed to either violent extremes.

In our own climate we enjoy, indeed, the advantages of temperate seasons, equally removed from the extremes of heat and cold; yet it is not without reason that we are sometimes tempted to be envious of the natives of milder climes. The sunny atmosphere of France, or the close warm azure of an Italian sky, may well seem to us a covetable exchange for our variable and fickle climate; our cold and drizzling spring; our uncertain summer and autumn, and our moist, bleak winter. Yet to the very variableness and inconstancy of our climate may we trace some of the highest social virtues by which

our nation is so peculiarly distinguished. We cannot have the festas of Italy or the fetes of France in the open air, or enjoy the dance and the song, as they do, fearlessly under warm, bright skies. But instead of these we have our pleasant firesides, our domestic comforts, and our social joys, all traceable originally to the inhospitable climate which drove us in doors, and gradually developed there those domestic joys which render "the homes of England," and their winter firesides more covetable than all the festas under the sunny vines of Italy or France. It is with a delightful consciousness of this best of all social blessings, so peculiarly our own, that the poet of the domestic virtues thus celebrates the closing season of the year, in the Task:—

"O Winter, ruler of th' inverted year,
Thy scatter'd hair with sleet like ashes fill'd,
Thy breath congeal'd upon thy lips, thy cheeks
Fringed with a beard made white with other snows
Than those of age, thy forehead wrapp'd in clouds,
A leafless branch thy sceptre, and thy throne
A sliding car, indebted to no wheels,
But urged by storms along its slippery way:
I love thee, all unlovely as thou seem'st,
And dreaded as thou art! Thou hold'st the sun
A pris'ner in the yet undawning east,
Shortening his journey between morn and noon,
And hurrying him, impatient of his stay,
Down to the rosy west; but kindly still
Compensating his loss with added hours
Of social converse, and instructive ease,
And gathering, at short notice, in one group
The family dispersed, and fixing thought,
Not less dispersed by daylight and its cares.
I crown thee king of intimate delights,
Fireside enjoyments, homeborn happiness,
And all the comforts, that the lowly roof
Of undisturbed Retirement, and the hours
Of long uninterrupted evening, know."

Here we see a remarkable example of the compensating processes by which Providence equalizes happiness,

and sometimes makes apparent discomforts and rivations the sources of our highest blessings. The Christian poet proceeds to picture the delights, with which thousands are familiar, when the pleasant winter fireside party is assembled, and music, or reading, or friendly converse, give wings to the hours; and then he confidently exclaims, "Is winter hideous in a garb like this?" Our reader, we will believe, is able and ready to answer this for himself. In the happy domestic circle, where brothers and sisters are met together around the hearth, winter is not hideous, but its cheerful fire, and even its shrill gusts, and drifting snows, seem to add to the comforts of an English home, and to make the fireside more delightful to all who share in its genial warmth.

It thus becomes a curious question, to inquire how far the social and political constitution, and the whole essential constituents of popular liberty, as developed in Britain, have had their origin in the variableness and ungenial moisture of its fickle climate. In no other country of Europe does the winter social circle present the same charms of affectionate and friendly association amid the true pleasures of home; and consequently in no other country are the rights by which the full enjoyment of these is secured more jealously guarded. To the increasing appreciation of these domestic joys, we may also trace the development of the social virtues, most characteristic of our own day; the increasing indifference to theatrical amusements, jovial club-meetings and the like, and the assumption even by our most popular public entertainments of a more social and intellectual character, such as marks the Athenæums, Polytechnic schools, and literary institutions of various kinds, as well as the amateur musical societies, which are now taking the place of the frivolous and even vicious popular assemblies of a former age. Among the various causes which have led to this happy change in the habits of the people,

much may be ascribed to the ungenial climate, which compels us to seek our chief happiness at home, and while it at no period of the year precludes us from all out-door exercise, yet rarely at any period permits us long to dispense with the genial attractions of the social hearth.

CHAPTER VII.

CONCLUSION.

We have thus endeavoured to glance over a few pages of the Book of Nature, endeavouring therein to trace some of the evidences of the Divine Author, and rightly to interpret some of the revelations of his wisdom, power, and goodness, which are therein recorded. The beloved disciple, John, after committing to writing, for the use of all future ages, the gospel which still bears his name, sums up the inspired record with these striking words: "There are also many other things which Jesus did, the which, if they should be written every one, I suppose that even the world itself could not contain the books which should be written." The world contains but a small part of that other record into which we have thus been glancing. For us it embraces, not the earth only, but the visible universe. Searching curiously into the hidden mysteries of creation, man has dug deep beneath the surface of things, and has ascended into heights almost too lofty for the most daring imagination adequately to follow. Beyond the Georgium Sidus, and far out of the reach of our unaided vision, science has discovered another world rolling through space, obedient to the same laws as those which control, not only the smallest planets of our system, but the minutest atom of matter on our own globe. That newly discovered planet moves through

its vast orbit, at a distance which we indeed state in figures, but concerning which our minds strive in vain to form any adequate conception: yet that distance is but as an atom when compared with the space which intervenes between the furthest limits of our system and the nearest fixed star. Science has, indeed, struggled to give definiteness even to that immensity, and to bridge over the mighty gulf, so that the mind may travel thither, resting on some defined form of thought; but fancy cheats herself in the attempt; and meanwhile the astronomer is still at work, sounding and guaging the depths of the heavens, striving to enumerate the countless suns in some single speck of the Milky Way; resolving nebulæ into unnumbered hosts of stars; discovering new nebulæ, still unresolved; until at length he is compelled to own, that, after having searched to his utmost, with all the added powers that science can confer, the universe still expands before him, and remains as deep a mystery to him as to the Chaldean shepherds who first watched the bright planets travelling in their courses through the starry canopy of night. But we have already seen that it is not needful for us thus to explore the immeasurable heights and depths of the universe which astronomy reveals to us, in order to conceive more adequately of the omniscience and omnipotence of Him who is from everlasting to everlasting. The geologist has opened up another field, wherein, though space be narrowed into the superficial crust of our little planet, time expands behind us, like the immeasurable depths of space spreading out before and beyond, as we feebly try to drop our plummet into its shallowest soundings. The igneous rocks, as well as the primary stratified formations, reveal to us only the evidences of change, and the mighty effects elaborated by heat and chemical agency in the vast laboratory of nature. But above these, we reach the secondary formations; and in the stratified rocks of the silurian system first disco-

ver the traces of organic remains. Here we meet with the shells of molusca, petrified fishes, and marine plants: the first evidences of a period in which animal and vegetable life existed on our planet. But when we begin to question science as to the date of this primitive period of organic life, the imagination has to cope with eras rivalling in their duration the vastness of the spaces with which the astronomer has to deal. Six thousand years is the whole term of existence of the human race; but the boldest geologist will hardly venture to assign the period which would suffice for the slow formation of these stratified masses, embodying sometimes within the space of a few inches, the remains of millions of living creatures, and extending to a thousand feet in depth. This, at least, we certainly know, that thousands on thousands of years before man was called into being, the Spirit of God had moved on the face of the waters, and God had said let there be light and life on this earth of ours. Good men have, indeed, been slow to admit the truth of this wonderful revelation of science; wisely withholding a too ready faith in discoveries which seemed to them at variance with the declarations of God's word. "In the beginning," says the inspired cosmogonist, "God created the heaven and the earth;" but it is justly remarked by a recent scientific writer, "Between *the beginning* spoken of in the first verse of the book called Genesis, and the creation of man, the most humble and devout of Biblical students now acknowledge the intervention of ages, compared to which the whole era of our race is but as the progression of the shadow one degree on the dial of time. Our whole written materials concerning all these ages are comprehended in the few introductory words of the Mosaic narrative; and for well nigh six thousand years no more was known. But all the while their history lay, in legible characters, around those generations who heeded them not, or read them

wrong." It is perhaps sufficient to remind the Biblical student, that, while the sacred narrative characterizes the very first period succeeding to the formless chaos, in which light appeared, as a day—" God divided the light from the darkness; and God called the light day, and the darkness he called night. And the evening and the morning were the first day."—Yet it was not until the fourth day that God made the sun and the moon, to rule over the day and over the night, and *to divide the light from the darkness.* It is, therefore, abundantly obvious, that whatever term of time we suppose to have constituted the three previous periods, they cannot have been solar days; for no sun existed, to rise and set in the heavens; and the light and the darkness were still indefinitely blended, in that transitional period between chaos and the beauty of a well-ordered creation, which, at each successive stage of its development, God pronounced to be good.

But we have seen, in the course of our investigation into the phenomena of the seasons, that it is not requisite for us to explore those vast fields wherein the imagination is lost in the boundlessness of creation, in order to form some adequate conception of the attributes of the Creator. The minutest of his works alike proclaim: "the hand that made us is Divine." The Spring discloses to us the swelling seed, the bursting bulb, the snow-drop, and the crocus piercing through the half-melted snow, and the birds already beginning their ingenious structures in the still leafless boughs. The Summer adds new and inexhaustible sources of instruction. Every leaf teems with life. The air is filled with the sounds of animated and joyous existence; the earth abounds with proofs of Divine beneficence, wisdom, and power; and nature opens upon us in all her fulness, defying as effectually the comprehension of all that she discloses, as does that wider universe to which the astro-

nomer directs his curious gaze. So is it with Autumn: rich in her abundant harvests, and no less fruitful in abundant mental stores, than in plenteous supplies for our bodily appetites. Last of all comes the Winter,—the sleep of nature,—with its snows, its ice, its decay, and withering, and death; and yet it, too, no less than all the others, abounds in proofs of wondrous wisdom, goodness, and power. God is indeed manifest in all his works. We cannot shut our eyes on the proofs which surround us, proclaiming for all existences a Divine Creator; for all governance, a Divine Ruler; and for all that is, animate or inanimate, a Divine Sustainer; without whom existence becomes inconceivable, even for a moment. Behind the visible is everywhere manifest the invisible Nature, law, and order; generation, vitality, reproduction, and all the instincts which so wisely guide the animate creation, will satisfy no intelligent mind as final causes. They are but steps in a process of reasoning, by which at length we reach to that great First Cause, the Alpha and Omega, the beginning and ending, the first and the last, the Almighty.

THE END.